THE

ELECTRICAL REVIEW.

VOL. XXXV. JULY 20, 1894. No. 869

CONTENTS:

	PAGE
State Munificence	57
The Modern Incandescent Lamp	58
The Lyons-Oullins Electric Tramway (*illustrated*) (*concluded*)	60
The Kennelly Combination Galvanic and Faradic Adaptor (*illustrated*)	61
Street Lighting by Alternating Arcs (*illustrated*)	62
Legal:—Brasyer *v.* Harness, McCully, and the Medical Battery Company (*continued*)	63
Latter *v.* Goolden	65
Correspondence:—The Electrolysis of Alkaline Chlorides	65
Variation of Electric Pressure	66
Tumbler Switches	66
Alternate Current Distribution	66
New System of Ship Wiring	67
Three Municipal Electricity Supply Works:—Derby, Manchester, Burton	67
Notes	79
Business Notices, &c.	82
Contracts Open and Closed	83
City Notes, &c.	84
Traffic Receipts	85
Share List of Electrical Companies	86
The Incandescence Lamp (*continued*)	87
Proceedings of Societies:—Royal Society (*illustrated*)	89
New Patents	91
Abstracts of Published Specifications	92

THE

UNIVERSAL ELECTRICAL DIRECTORY

(J. A. BERLY'S).

PRICE 4/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1894 ISSUE

PRICE 4/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGNERAY, LONDON." Code A B C. Telephone No. 517.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 8d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 8s, 10d.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

STATE MUNIFICENCE.

LAST week, at the annual meeting of the subscribers to the British School at Athens, the question of the State subsidy and recognition of scientific research was discussed by some very able speakers, including Mr. Asquith, M.P., and Mr. Bryce, M.P. (the President of the Board of Trade). The contrasts which were brought to light between British and foreign State munificence were far from flattering to the pride and dignity of English politicians. In deploring this grievous condition of affairs, the Home Secretary confessed that he was surprised, and to some degree ashamed, to hear that while France can afford £3,000, Germany £2,000, and America £1,400, as bounties to their respective Hellenic schools of archæological, artistic, and historical research at Athens, the generosity of Britain should stop short at the stinted sum of £400. He was anxious that the grants should be increased, but, at the same time, he had little confidence as to the result of an appeal to the Lord Chancellor for State aid towards the objects of science and the progress of art; nor could he suggest a scheme of taxation whereby money could be raised for the purpose.

It is encouraging to know that the Home Secretary is not ashamed to express his shame at this glaring example of State indifference; we venture to hope that when a few more authenticated facts of the same kind are put forward, his sympathies will be aroused to a point of redressing activity. In common with Mr. Bryce, Mr. Asquith was disposed to regard the matter as one simply of financing, and he looks for its solution, according to the usual formula, in some subtle trick of taxation. It is natural that politicians, *primâ facie*, should take this view; if, however, going somewhat more deeply into the cause of this defect, they would set the facts fairly before them, they would find the financial difficulty but the merest veneering of the real deterrent to State aid; they would be led to admit that those who have so far held the reins of this Administration have acted either in apathy, ignorance, or contempt of the more recondite researches of science, literature, and art; and it would appear to them beyond dispute that the State has been guilty of gross neglect towards those who deserve the greatest honour.

We do not deny that the suggestions of science, in so far as they apply to naval and military affairs, are noticed by the British Government; in such cases the Admiralty may invite tenders, or they may even arrange for their representatives to inspect the models working at some convenient music hall. But pure science it is inclined to regard with a languid sort of *insouciance* and pity, oblivious to the true worth or meaning of the researches, and ignorant of the benefits which it brings to every phase of life. We venture to think that when politicians grasp the meaning of scientific work,

and learn to estimate its successes at their proper value, the financial difficulty will absolutely disappear, and a general desire to honour the discoverers will be evinced. Finance is no real factor in these domestic problems; the British Government, we observe, can always find the *means* when it is confident of its *ends*; the Home Secretary has proved this himself on more than one occasion when he has finessed on matters far less obviously worthy of his support than the subsidy of scientific research.

We proceed to put our contention into shape by instancing a recent example of State indifference. Let us compare the treatment received at the hands of their respective home governments by the delegates sent last year to the International Congress at Chicago. France and Germany not only paid the whole expenses of their deputations, but rewarded the majority of them with decorations, and acknowledged their services with courteous thanks. Great Britain, with characteristic apathy, ignored its representatives altogether, the State granted absolutely nothing either by way of remuneration or gratitude; indeed, we doubt whether Her Majesty's Government knows even so much as the names of those who looked after British interests at this important Congress. It goes without saying that they were all men of the highest erudition; among their number was one whom foreign nations have honoured with more decorations than probably any single British civilian (with the exception, perhaps, of H. M. Stanley); his labours have wrought incalculable benefits, his inventions are every moment in requisition, he has never been given the slightest official distinction in his own country, and yet his greatest honour is that he gave his greatest discovery freely to the whole world. The inventor of the microphone is thought of less repute in his own country, officially, than the provincial mayor who gives a dinner to a prince at the expense of his townsmen; happily the nation itself judges these things with a better conscience than its legislators, and the men who go to discuss their country's interests with such *savants* as Helmholtz and Mascart have neither time nor inclination to seek for orthodox reputations or conventional honours; if scientific men really coveted these things they could easily attain to them by dabbling in the affairs of the navy, the army, or the diplomatic services; a few have tried this with some success, but the majority prefer to work in their own sphere. It is the honour of the State and not of the individual which is called into question, and it is to be hoped that the State will follow the excellent lead of Mr. Asquith and Mr. Bryce in helping forward every movement towards the needed reform.

THE MODERN INCANDESCENT LAMP.

L'Industrie Electrique contains a very full account of a communication delivered on June 6th by M. Larnaude before the Société International des Electriciens. The title of the article conveys to the mind the hope that the communication would contain new and important information on this subject, but its real purport is rather to set forth in a popular manner a comparison between modern attainments in lamp manufacture and the attainments reached some years ago, manufacturing details being wholly omitted.

M. Larnaude, who is the technical expert of the French Edison-Swan Company, commences by referring to the price of incandescent lamps. Only a few years ago the usual price at which it was sold was 5 francs, whereas now the price is only 1 franc; and, further, the quality of the cheap lamp of to-day is far superior to its more expensive predecessor. Several causes have brought about the perfection which has now been arrived at, to wit, competition with other illuminants and the general demand for electric incandescent lighting: but in the factory, the principal reason which has enabled the lamp to be made at so reduced a price lies in the perfection of detail in the various processes and the small amount of waste which now attends the manufacture. Formerly, to make 1,000 uniform lamps of a given voltage and candle-power, it was necessary to start making 4,000 or 5,000 lamps, while to-day the waste is reduced to about 10 per cent. The price of the lamp is now so low that any further reduction that may in the future be effected will be quite insignificant to the consumer. What is of importance, however, to the consumer, is the return of light which he obtains from his lamp and the current it consumes. By tables such as have often been printed, it was demonstrated how the cost of the current formed a far more important item than that of the lamp. It was therefore economical to run the lamps brightly at the sacrifice of their lives. But unfortunately a third factor enters—the lowering of the candle-power as a result of the blackening of the bulb and the disintegration of the filament. M. Larnaude has ascertained in an interesting manner that the depreciation in illuminating power is due in about equal proportion to these two causes. His method of investigation is to first measure a lamp on the photometer, and then, after it has become blackened by use and the diminution in illuminating power has been noted, to slowly let the air into the bulb by cracking off the pip. He then exposes the bulb to about a red heat (how, he does not say, but presumably by turning it about in a blow-pipe flame), when the thin film of carbon burns away, the bulb becoming clear again. The lamp is finally re-exhausted and re-measured on the photometer. With old types of blackened lamps he has found the loss of light due to the carbon film to amount to 25 per cent. to 30 per cent. In some instances the blackening may be due to special causes, but there can be no doubt that the usual phenomenon is the projection of particles from the filament. Owing to the perfection of the processes now employed, the blackening of lamps has been much decreased, and instead of forming rapidly in the early part of the run, the film now forms slowly and equally throughout the life of the lamp. As regards specific consumption of energy, the old types of lamps were started at 4 watts per C.P., and this rose after a run of 500 hours to 6 watts per C.P., and to 7 watts after 1,000 hours. Now, it is common to find lamps which start at 2·5 to 3 watts per candle, and do not exceed 3·5 watts after a run of 400 to 500 hours. At about this point it attains its economical limit of age as defined by Mr. O'Keenan a few years ago. In connection with economy of using lamps, M. Larnaude says that if two lamps are giving the same candle-power according to photometric measurement, but are running respectively at different watts per candle, the brighter one will be more agreeable to the eye, and at the same time will appear to give sensibly more light. Everyone, however, will not, we think, agree with the former of these contentions.

The various parts of the lamp are next considered. The filament is naturally the most important of these. Two conditions are essential: one is that the substance must conduct electricity, the other that it must stand a high temperature without fusing or changing in an appreciable manner. The hope is expressed that through the researches of M. Moissan it may eventually be possible to use for the incandescent medium certain homogeneous compounds of carbon with other elements, such as silicide of carbon. But so far nothing has been employed on a commercial scale excepting carbon. Up to a few years ago the carbons usually employed were made from vegetable fibres, either natural as used by Edison, or parchmentised cotton, as devised by Swan. Owing, however, to the lack of thorough homogeneity and uniformity of size of the carbons, the lamps were not very satisfactory or uniform, and the breakage during manufacture was heavy. It was true that the flashing or heating process, *i.e.*, heating the filament in a hydro-carbon gas or vapour, cured many evils of the foundation carbons; but at best it was only a paliative, and the evils were not cured as well as might appear at first sight. The root of the matter was to get a homogeneous foundation of hard and elastic carbon. This is usually done now by completely dissolving the vegetable or other compound containing carbon, and squirting the solution into a liquid which precipitates the material in the form of a homogeneous thread of uniform size. Or the material may be precipitated from solution in the form of sheets, and the sheet then shred into lengths of the requisite size. Another method, which it seems is being successfully employed, is, make a paste of finely divided carbon, with some decomposable binding material, and to squirt the paste by means of pressure. The modern homogeneous carbon used for filaments has a much lower specific resistance and higher specific gravity than the carbon formerly employed. Owing to the hardness the breakage in manufacture is slight, premature fracture of the filaments in the lamps is greatly diminished, and the lamps may be run at a higher temperature.

Various other technical points were next briefly touched upon, such as the calibration of filaments, the considerations attending the manufacture of lamps of small candle-power at high voltage, multiple filament lamps, and, finally, the most recent development of incandescent lighting, viz., lamps of large candle-power. Light for light, this latter type of lamp costs about double that of the arc lamp, but it possesses many advantages over its more economical rival. It requires no attention, and it can be placed in any position and used exactly where it is needed. It can be lit up and extinguished without trouble, gives a perfectly steady light, requires no enveloping shade, and produces a pleasanter light than the arc lamp.

With regard to the bulbs, which were formerly often blown in the blowpipe from tubing, the universal practice now is to blow them in a mould. The pumps used for exhausting the lamps are now very perfect, and consist of a combination of a preliminary exhaust by means of a mechanical pump, and then completed by means of the mercury pump, the whole being worked automatically by mechanical power. Finally, the leading-in wires which pass through the glass are always of platinum, though the length is now reduced to the smallest possible amount, the filament being supported by some other cheaper metal.

A Suggestive Experiment with Incandescent Lamps.

Amongst some experiments with carbon dioxide which are described by Dr. L. Bleckrode in the July issue of the *Philosophical Magazine*, the following is not only curious but suggestive. Four similar incandescent lamps (16-C.P. and same voltage), were connected in parallel to a dynamo; the first was filled with gaseous carbon dioxide, the second with common coal gas, the third with hydrogen, and the fourth was of the ordinary vacuum type. All carried a small piece of phosphorus at the top and on the outside of the bulb. The electric current was admitted to each lamp at the same time, and it was observed that the phosphorus became ignited at different times. First it burned on the lamp containing carbon dioxide, next on that containing coal gas, and shortly after on the lamp containing hydrogen; but on the ordinary lamp it remained intact for a long time. In the last case it may be inferred that the dark *heat* rays are very imperfectly transmitted by the vacuum, whilst convection, of course, must also be very much reduced; hence the glass can only receive a small amount of heat, and, as in Prof. Dewar's experiment, the vacuum prevents the ready access of heat to the extremely cold liquid, in the incandescent lamp, on the contrary to the cooling of the carbon filament. It can therefore attain a high temperature and convert the electric energy it receives chiefly into radiant light. As for the other lamps, the difference in heat transferred in the same time outside may find its explanation in the well-known experiments of Grove and the investigation of Clausius; yet it is a curious fact to see the carbon brightly glowing in the lamp whereon the phosphorus does not burn. In the lamp containing carbon dioxide the filament becomes only dull red, and in the others it remains obscure; but still the phosphorus burns there after a minute or so. Dr. Bleckrode believes that though the thermal conductive power interferes, convection plays an important part, and he ventures to predict that if the incandescent lamp, whilst glowing, could be intensely cooled by being immersed in liquid oxygen or liquid air, it would at once attain a higher illuminating power. As convection would still more be lessened, the remaining particles of air and mercury vapour would have their motion entirely exhausted; and hence it may be concluded that such a lamp would absorb less electric energy for emitting the same amount of light, when the degree of rarefaction is made the highest possible.

Galvanic Polarisation.

Those of our readers who are interested in studying the laws of galvanic polarisation and electrolysis, would do well to peruse a paper by O. Wiedeburg, in the *Annalen der Chemie und Physik* (Series ii., Vol. li., pp. 302—345). It may be asserted that these laws have never yet been properly codified; nor, indeed, have their relations been lucidly explained. Wiedeburg's paper, though a very long one, is little more than a step in this direction: an important step however. He seeks to give a coherent exposition of all the leading phenomena of galvanic polarisation, on the following fundamental assumptions:— The ions are driven by the active electromotive force towards the two electrodes, where they collect and generate new breaks in the potential, which, acting against the original electromotive force, regulate the current according to Ohm's law. All the ions that reach the electrodes, however, are not assumed to be electrically active, but only a comparatively small proportion of them. The rest are neutralised, thus losing their ionic character, and contributing nothing to the sudden difference of potential which sets in. Wiedeburg assumes, also, that there is a limit to the gathering of the ions at the electrodes, and the relative amount which collects at any instant is smaller, the nearer the amount already collected is to the limit, being proportional to the difference between the limiting and actual values at the instant considered. Some, perhaps, will be disposed to challenge these assumptions; but at least it will be admitted that the exposition which is based upon them is deserving of very considerable attention.

THE LYONS-OULLINS ELECTRIC TRAMWAY.

(*Continued from page* 29.)

When the hole is finished, we take a key as shown in fig. 1. This key is made of steel; its external diameter is exactly that of the hole, and the cylindrical groove is formed so as to act as a key. A drawn copper wire 8·25

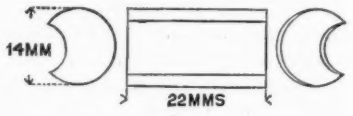


Fig. 1.

millimetres in diameter is passed into the hole and from the other side the key is wedged in; thus an absolutely certain connection is ensured between the copper wire and the rail. Fig. 2 shows the connections between the extremities of two rails and the manner in which they are connected to the rail placed opposite. By this method a completely metallic return circuit is obtained.

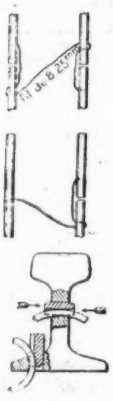


Fig. 2.

As the line is not very long, there is only a single feeder proceeding from the central station and extending as far as the entrance into Lyons by the Mulatière bridge.

Central Station.

The central station is situated at the Oullins dépôt, a few hundred metres from the Oullins terminus; the line will be extended later on to St. Genis-Laval. It consists of a building divided into two parts: in one are placed the boilers and accessories, in the other, the steam engines and dynamos and their accessories; this part is also the car house.

The car house for the self-motive carriages is furnished with a pit over which are placed the carriages when any one wishes to inspect the motors and the electric apparatus. In this pit is a hydraulic crane, provided with a tray, on which the motors can rest, and which serves to remove them in case of accident.

The dépôt of Oullins is situated on the banks of the Izeron, a small stream, the water of which is used for the boilers and for condensation. A well dug in the ground belonging to the dépôt gives a supply of water, which, if not very good, is at least passable, as is shown by the hydrometric tests. A brick chimney, 30 metres high, completes the station.

Mechanical Plant of the Central Station.

The mechanical plant of the central station does not present any feature of interest. The boilers are of the semi-tubular type and made at Lyons, being supplied by the firm of Bonnet-Spazin.

The steam engines, which are two in number, are also of Lyonnese manufacture, and were supplied by the firm of Piguet; they are 150 H.P., engines of the Duverger type, and capable of giving 200 if required; the speed is 100 revolutions. The great weight of the fly-wheel is worthy of mention, it being necesary in order to provide against the sudden changes that occur in electric traction; from 0 to 150 H.P. the speed should not vary more than 2 per cent., however sudden the variation of the load may be, and for the excessive load of 150 to 200 H.P., the variation in speed should be less than 5 per cent. We can understand that under these conditions the difference of potential at the terminals of the dynamos will be as constant as possible, especially as they are compound dynamos worked by belts, as we shall see presently.

Electrical Plant of the Central Station.

The electrical plant of the central station comprises two dynamos and two panels forming the distribution board. The whole of the electrical plant is of American construction, and is supplied from the Schenectady Works (New York); it represents the latest models of the General Electric Company.

Dynamos.

The dynamos are 4-pole machines, capable of giving 100,000 watts each. In reality, these machines may be overloaded 25 per cent., and it is under these conditions that they are tested at the works. They give at the terminals a difference of potential of 500 volts, without load, and are over-compounded for a loss along the line of 10

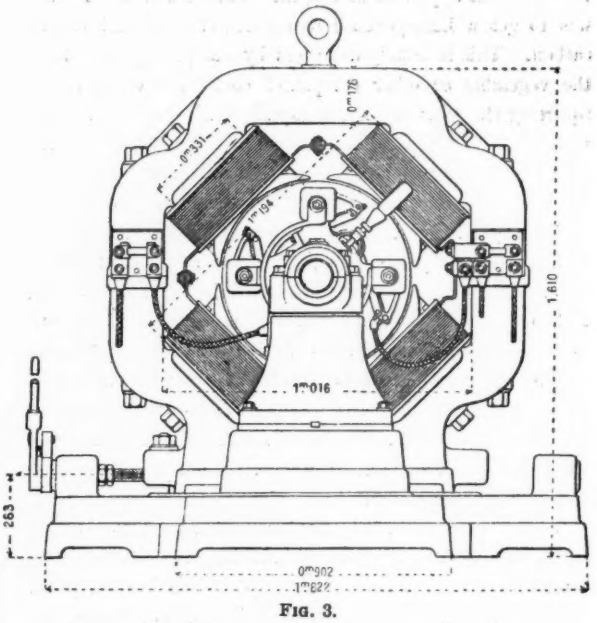


Fig. 3.

per cent., or 550 volts at full load; the armature makes 650 revolutions a minute.

Fig. 3 shows the front view of one of these machines.

We will examine the details of construction of this machine. It consists of four principal parts: the lower framework with the supports of the axle of the armature, the upper framework, the armature, and the foundation plate, which is substituted for the guides. By acting on the whole machine by means of a ratchet screw, we obtain the displacement on the foundation plate. The weights of the different parts are as follows:—

Lower framework	1,550 kg.
Upper framework	1,110 „
Supports of the axle...	325 „
Pole pieces	690 „
Armature	1,090 „
Pulley	140 „
Bobbins of the field magnets	320 „
Accessories	160 „
Total	5,385 kg.

Here are a few interesting dimensions:—

Armature, diameter	·635 m.
„ width	·415 „
Pulley, width	·381 „
„ diameter	·673 „
Width of the cast-iron crown	·465 „

Armature.—The armature is made of sheets of steel well annealed; these are cut into rings with indentations on the outer rim. The dimensions of these rings are as follows:—

Internal diameter	... ...	·305 m.
External „	... ...	·635 „
Thickness	... ...	·0004 „

Each ring has 145 indentations, in which the conductors forming the armature lodge.

In each of these niches are two bars of copper placed one above the other, the top one being longer than the under one.

The rings are fixed by means of two special bronze attachments keyed on to the axle, and which hold them as in a vice. These bronze attachments are formed of a hub centered on the axle and connected to a cylindrical piece by means of six arms; this cylindrical piece ends at one of its extremities in a shoulder-piece which extends all round the circumference and forms the jaws of the vice. By means of six bolts and six screws these pieces are drawn together and thus the plates forming the armature are tightened.

To make the armature the sheets that have been cut into rings are piled one upon another, being separated by sheets of paper. Apertures for ventilation are made at intervals normally on the outer surface of the armature. When the core is placed on the axle, the winding is proceeded with. Each indentation receives first a coating of insulating material formed of paper and mica stuck together with gum lac and about one millimetre in thickness. Then rectangular bars of copper, 5 × 7 millimetres, are introduced successively, endwise, having previously been insulated with a mixture of paper and mica; each niche is then finally filled up by inserting endwise a wedge of beechwood. We see that by this method we get at each indentation a powerful pressure without having recourse to tightening wires of German silver or steel, which have long been employed. The insulation thus obtained is perfect; sometimes a substance known as micanite is substituted for the sheets of paper and mica; this is obtained by moulding, according to the dimensions required, a mixture of mica chips and gum lac. This substance can resist a very high temperature without becoming carbonised, and by its use armatures that are practically incombustible are obtained.

When the indentations have been fitted with copper bars, we proceed to the connections. The method of winding employed is that of series winding applied to a drum armature and a four-pole machine. For this purpose the upper bar of one of the indentations is connected with the lower one of the indentation situated at 90 degrees from it; this connection is made by means of a folded band of copper, which is, of course, covered with insulating material. To connect the bands of copper to the bars, there is a longitudinal slit in the extremities of the bars into which the band passes; they are then fixed by little copper hooks inserted into holes made, for the purpose, and the connection is completed by soldering.

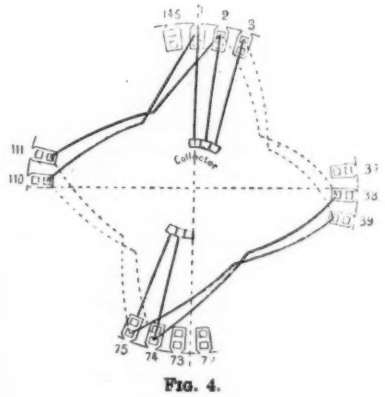


Fig. 4.

The method of winding is shown in fig. 4. We will suppose that the armature is facing the collector and that we start from the first indentation. From the upper bar of No. 1 the current goes to the corresponding plate of the collector and also to the lower bar of No. 110 from the side of the collector; it then passes through this bar to the other side of the armature, proceeds to the upper bar of No. 74, thence to the collector and so follows this bar, returns to the front, goes to the lower bar of No. 38, follows it, passes behind, goes to the upper bar of No. 2, follows it, returns in front to the collector, and to the lower bar of No. 111, and so on. By this arrangement two brushes at 90 degrees would be sufficient to collect the current: but in these machines brushes of coppered carbon are used, and in order to lessen the heating of the brushes, four brush-holders are connected two by two in parallel. Each brush-holder holds two brushes in the form of a parallelopiped having one of the faces, the one resting on the collector, bevelled; the dimensions of these blocks of carbon are 90 mm. long, 57 mm. wide, and 12 mm. thick.

Field Magnets.—The pole-pieces are of wrought-iron with rectangular section, they are expanded at their extremities so as to embrace a larger surface of the armature; the density of the lines of force in the pole-pieces is 8,600 per square centimetre; in the *entrefer*, which is only three millimetres, the density of the lines of force is 4,000. The pole-pieces are fixed on the body of the machine by means of bolts. With the exception of the pole-pieces, the whole body of the machine is of cast-iron.

The coils placed on the field-magnets are the shunt winding, formed of fine wire and the series winding. The shunt winding forms a bobbin, the series winding is done with the bands of copper, and is placed on a separate bobbin placed opposite the first. The various parts of the series winding are connected by means of a little copper bolt which presses the two extremities of the copper bands tightly together.

When the machine is being constructed, it is very difficult to wind just the quantity that is necessary for the machine to be over-compounded for a certain percentage; moreover, if we wanted a machine to be over-compounded for a different loss along the line, say, 15 to 20 per cent., a fresh armature and fresh field-magnets would have to be constructed. The following method enables these various modifications to be effected in a very simple manner. A larger quantity of wire is wound than is necessary for the required over-compounding, and adjusted by means of a shunt of German silver placed on the machine; we can thus obtain the desired effect with very great facility. One special feature of these dynamos employed for electrical traction is their strong construction; in every part we can see that material has not been spared. They show the defects of the American construction as well as its advantages; they have not the finish to which we in Europe are accustomed, and it is plainly evident that these machines are constructed in series. Another graver fault is the number of revolutions which is considerable for a machine of such power. It being the custom in America to work dynamos of 100 kilowatts by high speed engines of the Armington and Sims, Ideal, MacIntosh and Seymour types, the speed of 650 revolutions entails no inconvenience. But in France where preference is rightly given to lower speed engines, such as the Corliss engine, which makes from 55 to 65 revolutions, we should be obliged in order to work similar dynamos to have recourse to fly-wheels of too great diameter. It is, moreover, easy to make dynamos of 100 kilowatts, without any appreciable increase of weight, turning at a speed of 30 to 40 per cent. below this.

(*To be continued.*)

THE KENNELLY COMBINATION GALVANIC AND FARADIC ADAPTOR.*

One of the most urgent inquiries of the progressive physician of to-day is for an instrument which he can use with the Edison 110 or 120 volt direct current for all the varied forms of electro-therapeutic treatment with absolute safety to the patient, and at the same time be able to graduate and control it within the finest limits, and also accurately measure

* New York *Electrical Engineering.*

the strength of the current he is employing. Such an apparatus is here illustrated as designed by Mr. A. E. Kennelly, with a special view to fulfilling all these requirements.

It consists of a hard rubber cylinder, upon which is wound in suitable grooves, cut on the face of same, several hundred feet of German silver wire, having a very high resistance.

Near the end of the cylinder on the left, very high resistance carbon blocks are introduced into the circuit, making the total resistance about 33,000 ohms. This rheostat is regulated by the sliding contact which travels along the two rods above and parallel with the cylinder.

A 16 C.P. lamp is placed in circuit with each of the leading-in wires to protect effectually the patient and apparatus should a short circuit occur on any part of the electric light circuit.

A third lamp shown in the extreme right, provided with a key, is arranged in shunt with the rheostat. When the key is turned on, the voltage of the galvanic current is reduced to 60 volts. With this shunt in operation, and all the resistance of the rheostat thrown into the circuit by moving the sliding contact to the extreme left, a current of one milliampère is obtained when the binding posts are connected together by a short piece of wire, *i.e.*, short-circuited. On moving the sliding contact to the right, the resistance is very gradually diminished, and the current correspondingly increased. This finely graduated current is required in some cases, where a very slight irregularity in the current would produce a shock to the patient. When a stronger current is required, the lamp is cut-out by turning off the key and the current is used unshunted.

The well-known Kennelly milliammeter is mounted on the base on the left, the pole changing switch is placed in the middle of the board, while on the right is shown the faradic coil, which is also operated by the street current.

This is of the Du Bois-Reymond type, the secondary being wound upon a separate spool, removable at will. The secondary winding consists of 18 layers of No. 34 wire, having a total length of about 1,800 yards. The winding is tapped in six places, so as to divide the coil into six sections, each section consisting of three layers of wire, the whole being connected in series. By this arrangement 3, 6, 9, 12, 15, or 18 layers of secondary winding can be used as required, by moving the switch shown at the end of the coil.

Each section produces an entirely different sensory effect, the current in the first section being very stimulating, whereas the current in the sixth section is of a very pleasing character and produces a sedative effect, the character of the current in the other sections being intermediate between the two extremes. When first put in operation, the secondary coil always moved to the extreme right, so as to leave the primary uncovered, the strength of the current being increased by slowly moving it towards the left, so as to finally cover the primary coil.

The current in the primary, on the contrary, is at a minimum when it is entirely covered up by the secondary coil, which in this case, must be short circuited by a switch provided for that purpose, and it is increased by sliding back the secondary coil to the right.

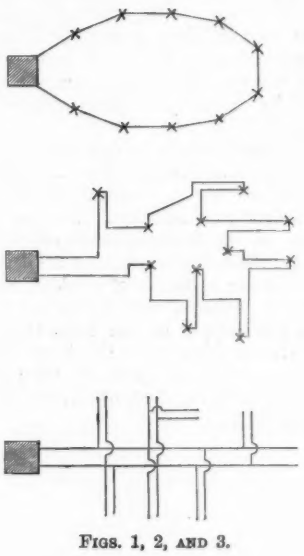
When the switch at the back of the pole changing switch is turned on, and the vibrator set in motion, the current from the galvanic binding posts is now of a pulsating character, as the primary of the faradic coil is superposed on the straight galvanic current, thereby producing the pulsating current as described by Dr. de Watteville. The strength of these two combined currents is controlled by the rheostat in the ordinary way.

It is thus possible to obtain for this instrument: 1st. The direct galvanic current of 120 volts. 2nd. The direct galvanic current of 60 volts. 3rd. The primary faradic current capable of six variations, depending on the number of sections of the secondary coil that are short-circuited. 4th. The six secondary faradic currents, all of which manifest distinct characteristics. 5th. The primary faradic current superposed on the 120-volt galvanic current. 6th. The primary faradic current superposed on the 60-volt galvanic current. The instrument is handsomely mounted on a polished quartered oak case and enclosed in a bevelled plate-glass case, provided with a lock.

STREET LIGHTING BY ALTERNATING ARCS.*

By CHARLES G. ARMSTRONG.

At first thought, the planning of a street lighting system for a city and using multiple instead of series wiring may seem expensive, but let us look at both sides. If we plot the ideal town plant we find the lamps all arranged along a circle or loop about as shown in fig. 1, and no doubt the series arc system with a single wire is then the simplest and cheapest. But in practice we find that the towns are not often laid out to suit such simple wiring plans, while councilmen Smith and Jones and Brown all have their notions as to the location



Figs. 1, 2, and 3.

of the lamps; so the actual diagram is more like fig. 2, much of the wiring being in loops so as to nearly double the length of the circuit. Of course every foot of this wire has to carry the full current (say 10 ampères), whereas in a multiple system, like that shown in fig. 3, the size of the wire would diminish as we get farther from the stations, both systems using about the same voltage (2,000). This difference in the cost of the wire may be very considerable. In the case of a 60-light town plant for which I recently made the estimates, the alternating current transformer system showed a saving of 10 per cent. on the wire over that which would have been needed for the same lamps on the ordinary series circuits.

As to the arc lamps themselves, there has been quite a change during the past year in the voltage adopted for them.

* Abstract of a paper read before the Chicago Electrical Association.

The early forms were adapted to be run from 50-volt transformers with a resistance in series. Then this resistance was gradually reduced so as to run three lamps in series on a 100-volt circuit, thus giving better results and taking less energy. Lately the manufacturers have gone a step further by planning their lamps to work direct from 30-volt transformers, leaving out all resistance. The lamps themselves are as economical as the series lamps, each consuming about 450 watts for a nominal 2,000 candle-power. Of course there is the extra cost of the transformer, but this, together with the alternating arc lamp itself, costs no more to-day than a first-class series lamp. The loss in the transformer does not count for much, as the transformer is always worked at full load, and therefore at its greatest efficiency. What is more, the transformer tends to steady the fluctuations in voltage at the lamp, so that this cannot creep up to 50 or 57 volts as it often does with series lamps.

One of the advantages gained by running arc lamps in multiple is that every lamp is independent of the rest. If a lamp should get out of order, it would keep its crankiness to itself without affecting all the others. Indeed, the most that it could do would be to short circuit itself and blow the fuse of the transformer. The same advantage is found in case of a break on the line, as this only cuts out the lamps beyond the break instead of crippling the whole system. Likewise, only the joints between the given lamp and the dynamo interpose their effective resistance, while in series systems any and all bad joints affect the whole number of lamps. The voltage used at the lamps is harmless, they can be trimmed with safety at any time, and it is comparatively easy to plan the feeders for safety.

As to the illuminating power of the lamps, the direct current arcs have the advantage of throwing out most of the light-giving rays in a downward cone, whereas the alternating arc sends out a double cone of light. By using a reflector much of the upward projected light can be thrown downward, and in the case of street lighting a portion of the rays will be reflected from the under surface of the foliage. So I think that for the low suspension commonly used throughout the country the alternating arc is the proper one, while for tower lighting the direct current arc would be preferable.

In comparing the energy of the two systems, the commercial efficiency of the dynamos and the cost of armature repairs will also be an important item. Good series generators show an efficiency of from 80 per cent. to 85 per cent. when built, but after a few years this falls to 70 per cent., and often as low as 50 per cent. On the other hand, we can count on from 85 per cent. to 90 per cent., or even 92 per cent., when using alternators, and can figure on quite a saving for armature repairs. I have seen figures from 300 arc light stations which average $3.00 per year per arc lamp for armature repairs alone. This agrees with the commonly known fact that arc armatures are much more likely to be damaged than those of an alternator. I believe that under similar conditions an alternating armature will outlast from two to three arc armatures.

The matter of carbons for alternating arcs has been an important question, as a fine grade is needed for this work. The lamp manufacturers have wisely taken the expedient of using an enclosing globe, so as to make a carbon last 18 hours which otherwise would be consumed in 14 hours. Moreover, the carbon manufacturers in this country are hastening to bring out a grade of carbons suited for alternating current work, and the probability is that we can soon purchase American carbons for these lamps at prices not much in advance of that charged for the hard series arc carbons.

I have already spoken of the greater efficiency which we can readily expect from the alternating generators. We can also get them in larger sizes, so that in place of from 12 to 20 series machines, each with a capacity of 80 to 100 lights, we would have, say, three generators of 300 to 400 horse-power each, these being preferably slow speed machines, connected direct to the engines, thus doing away with belts, ropes and shafting.

At present the common voltage for the primary circuits is about 2,000, having grown to this point from 500, from which it started, and I believe we can assume from 2,000 to 2,500 volts as our settled standard. Still, if I were to plan an ideal arc lighting plant for a large city, I would choose a still higher voltage, perhaps 4,000 volts. My station would be some three or four miles out of town, and I would run my wires in conduits to some distributing centres in the city, transforming at these points to 2,000 volts, and running thence to the alternating arcs.

Figure out such a plant for a good sized town, and note the saving in circuits alone, as compared with series circuits which have only from 50 to 100 lights each. You will then see what the prospects are for the extensive use of alternating currents in connection with street lighting by arc lamps.

LEGAL.

Brasyer *v.* Harness and Others.

Sixth Day's Proceedings.

We give herewith counsels' speeches and the text of Mr. Justice Charles's summing up.

On Tuesday, Mr. Abinger continued to address the jury for Dr. McCully. Mr. Hannay, the police magistrate, had, he said, already dismissed the case against his client, on the ground that no jury could convict. Notwithstanding this, the jury were now asked to say that the charge of obtaining money by false pretences was well founded. They were further asked to find that Dr. McCully was guilty, as a medical man, with having so negligently treated the Colonel as to seriously injure his arm. The injury was said to have been inflicted on June 20th, yet the plaintiff continued his visits to Oxford Street to be treated by the same man until far into July; he continued on the most friendly terms with Dr. McCully as a brother officer, and when the Colonel became ill, it was Dr. McCully that he sent for to attend upon him. The prosecution of Dr. McCully at the police court was instituted and carried on maliciously, and for this malicious prosecution the jury must award him substantial damages.

Mr. Witt, replying for the plaintiff, maintained it had been clearly proved that when the defendants obtained the £52 10s. from Colonel Brasyer they knew that they could not do the poor old man any good. With regard to the counter-claims for damages for malicious prosecution, the learned counsel remarked that no prudent man would commence criminal proceedings if the law were that an action would lie simply on the ground that the prosecution had failed. Before an action for malicious prosecution would lie, it must be shown that the prosecutor had been actuated by an improper motive. In this case Colonel Brasyer had reasonable and probable cause for the course which he took. There was the knowledge that most severe things had been written about Harness, and he had been called a swindler and a rogue. If a man had been libelled and he chose to take no notice of it in the law courts, he could not have those libels used against him. But if the man resented those libels, and said, "I will prove I am not the swindler you say I am;" then issued a writ in an action for libel, and then the defendant replied, "I will prove that my words are true," that made it a different matter. If a man brought several actions for libels, and when the defendants pleaded justification for their words the plaintiff drew back in the face of his accuser, had not every man in the country the right to believe the statements written were true? There was no difference between the man who brought actions and then withdrew his claim and the man who wrote a confession admitting his guilt. The first confession was made in the action brought against the Electrical Review. Then came the second confession made in bringing the action for libel against *Science Siftings*, and when justification was pleaded by the defendants, Harness's company settled the action by paying £1,300. Mr. Harness was the most unfortunate man in the world in regard to his legal advice. Mr. Harness, and his solicitor, Mr. Fleet, said that the £1,300 was got from them by fraud, but they never took any steps to get the money back. All these libels were put to Mr. Harness in the witness box not for the purpose of blackening that poor man's character, but were put forward in the nature of confessions. Mr. Harness did not continue his action against the proprietors of *Science Siftings*, because he said they were poor men. Then he began an action against Mr. Astor, the proprietor of the *Pall Mall Gazette*, and he discontinued that action, not because Mr. Astor was too poor, but because he was too rich. Mr. Harness seemed very hard to please in regard to his opponent, but at length he fought Colonel Brasyer, apparently because Colonel Brasyer was a kind of middle man, neither too poor nor too rich. Coming to the question of the belts themselves, Mr. Witt said it was idle to discuss the unconnected belts because everybody agreed that they were no good. But as to the connected belts, it was clear that there would be a small current, but if the webbing got saturated with perspiration, the current would go into the webbing. Even supposing there was a current, the evidence was that it did not penetrate into the body. But putting it as favourably to Mr. Harness as possible, and assuming that a small current did get through the skin and into the body, that was a long way from curing all the various evils the flesh was heir to. It was a rash and false statement to advertise these belts are a cure for all sorts of diseases. These assertions in these pamphlets were reckless assertions, made by one of the most ignorant men that ever lived. Having regard to all the circumstances, was not the reasonable conclusion that all this establishment was a gigantic fraud? By his advertisements, Mr. Harness wanted to make out that he was a great public benefactor, and ought to rank with all the great medical men who had discovered cures for various diseases. Mr. Harness had also attempted to puff up his wares by the use of the name of Dr. Vigouroux, of Paris, and although Dr. Vigouroux was very angry

and ordered his name not to be used in 1890, yet in 1892 his name was still being used. In commenting upon the testimonials, the learned counsel admitted that the belts may have done good by the method of "suggestion." It was really "faith healing," just as persons in the reign of Charles II. were cured of King's evil by the touch of the king. Wearing a Harness belt was like wearing a charm or amulet, and if Mr. Harness advertised it in that way it would be all very well. Continuing his address, the learned counsel asked the jury to say that Colonel Brasyer did believe in the case put forward in the police-court, and that his agents and solicitor did use every reasonable inquiry, and did not put the law in motion without careful and proper consideration. The jury must also find in Colonel Brasyer's favour that Dr. McCully had been properly included in the proceedings. Colonel Brasyer honestly believed that a crime had been committed.

The Summing-Up.

Mr. Justice Charles, in his summing up of the case to the jury, said the complaint of Colonel Brasyer was that by false representations Harness and McCully had tricked him out of £52 10s., and also two smaller sums of 10 guineas and £10. The plaintiff alleged that the representations made in the advertisements were false and fraudulent, and false and fraudulent to the knowledge of Messrs. Harness and McCully. For the defence it was submitted that Harness had not personally and verbally made any representations at all, and that if the advertisements were false, they were issued by the Medical Battery Company, of whom Harness was only a salaried servant. But if the jury believed the evidence, there was evidence that beyond all question C. B. Harness was the real principal, and that he individually, as a man and not as mere manager, had been a party to the issue of these countless advertisements and pamphlets. The jury had only to take one of these pamphlets in their hands to see that the fact was so, because the name of C. B. Harness was in the pamphlets. Therefore, as regarded Harness, the legal difficulty presented by Mr. Jelf did not arise. Colonel Brasyer had not been called before the jury, but in his sworn evidence he stated that the false pretence was the defendants represented that, by means of certain electrical appliances, they could cure him of his weakness in the loins. The plaintiff said that by means of the false representations in the pamphlets and advertisements the defendants got the money out of him. The law treated persons as guilty of false representations, knowing them to be false, when people put forward false statements recklessly, without troubling themselves whether the statements were true or false. His Lordship remarked that several of the pamphlets purported to be "by C. B. Harness, consulting medical electrician." But Mr. Harness, it was no exaggeration to say, had no medical education. What Mr. Harness said he meant to convey to the public was that he was surrounded by a staff of competent medical men. The Medical Battery Company was started in 1884, premises were taken in Oxford Street, and undoubtedly a large amount was spent in electrical appliances. It must be said in Mr. Harness's favour that about this time he advertised in several papers that he did not hold himself out as a medical practitioner. Then, under the guidance of M. Loreau, of Paris, Mr. Harness fitted up the premises at Oxford Street with appliances for treating people by statical electricity. Then he and his wife were stricken with paralysis, and he said they derived great benefit from the electrical treatment. But the great question was whether he was entitled to represent himself as a competent medical electrician. The plaintiff alleged that Harness represented himself as "highly skilled in the treatment of patients suffering from the same complaint as the plaintiff." It was not denied that the connected belt might produce a current of electricity; but the point was that the plaintiff said defendants held out this belt as a competent appliance to cure disease. It was not sufficient to find that the belts were electrical appliances; the defendants had advertised them as appliances which would cure innumerable diseases. The learned Judge read extracts from some of the pamphlets, in which the belt was advertised to cure nearly every disease, from rheumatism to premature old age. Could any human being in his senses suppose that all these diseases yielded, or could yield, to this treatment? One of the charges made was not that a current of electricity was not produced, but that the public and Colonel Brasyer were informed that these electrical appliances could cure, or alleviate if they did not cure, pretty well every ailment that flesh was heir to. Was it not an element of quackery that the same remedy should be advertised to cure so many various diseases. It must be remembered, however, in his favour, that Mr. Harness had put a large sum of his own money into this company. After reading the evidence of several of the medical and scientific witnesses, Mr. Justice Charles said the jury must judge for themselves whether these belts had any curative medical effect. Mr. Gatehouse had given evidence of the sort of currents which he had found by experiments could be created by these connected belts. But it must be remembered that Mr. Gatehouse, from the very starting of this company, had taken a very decided view of these belts, and had described the alleged curative properties to be absolute quackery. Going back to the plaintiff's own evidence, the Judge observed that Colonel Brasyer stated the first question addressed to him when he went to 52, Oxford Street, was, "What are your finances?" He was then asked to sign a cheque for £52 10s., and he did so. All this happened before anyone asked what was the matter with him. Colonel Brasyer said he was afterwards taken upstairs to Dr. McCully, who put him in the statical machine, and that Dr. McCully then performed a lot of antics, such as the fakirs in India performed. With regard to this part of the evidence, the Judge said it was a pity they had not seen the plaintiff in Court, but they must judge of him as best they could from his printed evidence. Personally, he thought the plaintiff was exaggerating, and that what he described as an incantation by Dr. McCully, was merely the application of the statical machine. Dealing with Dr. McCully's case, the Judge said he had had an unfortunate career; but it could not be said of him as it could of Harness, that he was devoid of medical knowledge. He had written a most atrocious libel, and suffered the maximum penalty, his name being removed from the Medical Register in consequence. Then he became a servant of the Medical Battery Company at a salary of £350 a year. In the witness box, Dr. McCully said as soon as he saw Colonel Brasyer he examined him, and found nothing the matter with him except senile decay. He also said he told Colonel Brasyer that electricity could do him no good. The jury would have to decide whether they could believe this, but, at any rate, Colonel Brasyer underwent the treatment for which he had already paid £52 10s. As to the charge of negligence against Dr. McCully, and of injuring the plaintiff's arm, it should be remembered that Colonel Herbert's evidence was that Colonel Brasyer made no complaint of any such injury until the dispute about McCully's bill at Margate. When Colonel Brasyer was refusing to pay the bill of £47 to Dr. McCully for private attendance, he alleged that his arm had been injured at Oxford Street. The questions which he should leave to the jury on the first part of the case were:—Whether Harness and McCully, or either of them, and which of them, had been guilty of false representation; and was Colonel Brasyer induced thereby to pass the sums of £52 10s., 10 guineas, and £10, or any of them. Whether Harness and McCully, or either and which of them, had been guilty of treating Colonel Brasyer negligently or unskilfully? The evidence, his Lordship went on to remark, was that Dr. McCully denied having done Colonel Brasyer any harm by the application of the statical electric machine. On the other hand, there was the word of the old Colonel that he had been so injured. If it was made out to the satisfaction of the jury that the plaintiff had been so injured, then they must find McCully and Harness—if they found that Harness was the real principal in this matter—guilty of negligence. The jury must ask themselves how much money Colonel Brasyer ought to receive in reference to that negligence. But, even if they were convinced that Colonel Brasyer had been treated negligently, his injury did not seem to have been a very serious one. The old man seemed to be well now, and the injury did not appear to have been a very serious one at any time. So that if the jury found for the plaintiff on that part of the case, they would give him very moderate compensation for the mistake made with the machine. His Lordship then directed the jury's attention to what he called the other part of the case, and said that in summing-up the facts of the first part of the action he had already said a great deal which would apply also to the second action. The second action was the action for damages for malicious prosecution. The case was almost like two actions, and the jury must discriminate between the action of Harness and the action of McCully. The action of malicious prosecution was the most difficult one to have to try. In order to make out a case of malicious prosecution, a man must show, firstly, that he was prosecuted, secondly, that the prosecution failed, and thirdly, that the prosecuting person, not his agent, did not honestly believe in the case which he laid before the magistrate. To support this action it must be made out that there was an absence of reasonable and probable cause for the prosecution. Whether there was an absence of reasonable and probable cause the judge would have to determine from the way the jury answered the other questions. The jury were not trying the question whether the prosecution was right or wrong The question was whether the prosecutor had reasonable cause for putting the criminal law in motion. It was not needful for the prosecutor to come before the jury and say: "I put the criminal law in motion because the man was guilty." If Colonel Brasyer had showed that he had reasonable and probable cause for the proceedings, the action for malicious prosecution could not succeed. The defendants must show that the prosecutor himself, not his agents, was actuated by malice, that was, some improper motive. The desire to get back his money by commencing criminal proceedings would be a wrong and improper motive. The jury must say:—

Whether Colonel Brasyer in prosecuting Harness and McCully honestly believed in the case he laid before the magistrate. They must consider whether Colonel Brasyer believed it, not whether his solicitor, Mr. Colyer, or Mr. Marks believed it. They would give their verdict (1) as regarded Harness, and (2) as regarded McCully.

Whether Colonel Brasyer, or his agents, acted with reasonable care in investigating the facts of the case before they instituted the prosecution (1) against Harness, and (2) against McCully.

Whether Colonel Brasyer himself had a malicious mind.

If the foregoing questions were answered against Colonel Brasyer, then what damages (1) Harness and (2) McCully were entitled to.

Mr. Harness had said that he was ruined utterly; that he had lost his salary of £2,000 a year; also his whole fortune; that he had been treated with ignominy, confined in a police cell, and was entitled to damages in that behalf. If Colonel Brasyer had acted with malice, he was liable to pay Mr. Harness damages. So with regard to McCully. He, too, had lost his salary and his position, and claimed to have suffered injury to his reputation by the prosecution instituted against him. Then it would be for the jury to say whether they thought Colonel Brasyer or his agents exercised reasonable care in investigating the facts before preferring the criminal charge. Now the evidence was that Mr. Colyer, the plaintiff's solicitor, had this matter left entirely to him. What did Mr. Colyer do? He said he made himself acquainted with all the previous actions of the Medical Battery Company. There was the Alabaster action, in which the Medical Battery Company had to pay £1,000 damages, and had to settle the other actions against the Electrical Review. Then *Science Siftings* were attacked. This paper said they intended to establish the truth of the alleged libels. Then *Science Siftings* said: "Why you have libelled us just as you did the Electrical Review, by saying we have libelled you." What did the Medical Battery Company do? They positively paid the people they alleged had libelled them £1,300. They did not proceed with their own action for libel, and they paid on the counterclaim £1,000 damages and £300

costs, to get rid of this action. The jury had heard the story told by Stockman, how he claimed to get a withdrawal of all imputations but did not get it. He got a receipt for the £1,300 which did not say a single word about withdrawal of imputations. *Science Siftings*, after having delivered this tremendous battery and libel against the Medical Battery Company, published a notice to their readers that they had won the day. What would a firm acting in the interest of somebody who said he had been defrauded by Harness be bound to think. Mr. Colyer knew of all these actions being withdrawn and damages and costs paid. He knew of Alabaster getting £1,000 damages; of Harness *v.* Alabaster being withdrawn and costs paid: of the action against *Science Siftings*, and of the intention of *Science Siftings* to go into Court and say that every word of the alleged libel was true. Then in the latter part of October the *Pall Mall Gazette* set to work to publish a series of articles against Harness. Therefore, before the prosecution was instituted, Mr. Colyer had before him the extraordinary circumstances that the Battery Company had settled three actions, and with regard to one of the three Harness himself had been a party to the settling. On the top of all this came the articles in the *Pall Mall*. Mr. Colyer also provided himself with some of these pamphlets issued by the Battery Company. He also enquired into McCully's antecedents, and found out the incidents in McCully's career. Mr. Colyer took counsel's opinion on the case, and as to the proper course to adopt. The Medical Battery Company having gone into liquidation on the 3rd of the month, on the 6th this prosecution was instituted. The jury were asked to say that because warrants were asked for against Harness and McCully that that was evidence of malicious intention. In view of what Mr. Colyer had known, and of the previous actions, it was impossible for him not to come to the conclusion that this business at 52, Oxford Street, was a nefarious business. Then he ordered warrants to be applied for. Under these circumstances, did the jury think that Colyer kept all this knowledge to himself, and did not tell Colonel Brasyer about it? It was perfectly incredible that he should keep it to himself. Colonel Brasyer did not say that he was not told all about it; but, on the other hand, he said he left the conduct of affairs to his solicitor. His Lordship said he thought Mr. Colyer said the old man had read the articles in the *Pall Mall Gazette*.

A Juryman: Yes; that is so, my Lord.

Mr. Justice Charles, continuing, said it was impossible to suppose that these material facts were kept from Colonel Brasyer, and if all these material facts were known to Colonel Brasyer, what could be said about his not honestly believing that he had been defrauded? Did the jury think he had an honest belief in the case presented on his behalf. Could the plaintiff's agents have done more than they did? What was the legitimate conclusion at which a man of sense would arrive under the circumstances? Did they think the legitimate conclusion was a prosecution? If the jury found that plaintiff took a reasonable course in the prosecution, then there would not be much trouble for him (the judge). As to the explanations of Mr. Harness for the settlement of other actions, the jury must judge for themselves. Colonel Brasyer having come to the conclusion that he had been cheated out of his money, and knowing that on three separate occasions, rather than face a trial where the direct issue would have been whether this business in Oxford Street was a swindling one, or not, the company had paid considerable sums of money in damages and costs, did he act with malice in prosecuting the defendants? The defendants alleged that it was an utterly baseless prosecution, and that it was brought by Colonel Brasyer for the purpose of getting back his money. Again, was there justification for prosecuting McCully. The jury must give the fact that McCully was a salaried servant its due weight, but no more. If they thought he was an innocent servant of Harness, and if they thought the business carried on at 52, Oxford Street, was not a genuine business, but very much the reverse of genuine, then they must give the fact of his being a salaried servant its due weight, and no more.

The jury retired to consider their verdict at 3.50.

They returned into Court after an absence of nearly two hours. As to the first question, they said they were not agreed as to whether Mr. Harness induced Colonel Brasyer by false representations to part with his money; but they agreed that Dr. McCully was not guilty of false representations. On the second question, they found that neither Harness nor McCully was guilty of treating Colonel Brasyer negligently or unskilfully. As to the cross actions for malicious prosecution, they could not agree whether Colonel Brasyer honestly believed in the case that he laid before the magistrate, nor whether he was actuated by malice, nor whether his agents acted with reasonable care in investigating the facts before proceeding criminally.

Mr. Justice Charles asked if there was any chance of the jury agreeing upon the latter part of the case if they devoted some further time to its consideration?

The Foreman of the Jury: There is no chance of our agreeing, my lord.

Another Juryman: We are equally divided in opinion on the rest of the case.

The jury were then discharged.

Mr. Abinger asked for judgment for Dr. McCully in the first action, with costs.

Mr. Justice Charles: I give judgment in that action for Dr. McCully with costs. As to the second case, on which the jury have not given a verdict, I will have that put down for argument upon a day to be arranged by counsel.

In the Queen's Bench Division, on Friday last, the case of Brasyer *v.* Harness and McCully again came before Mr. Justice Charles.

Mr. Witt, Q.C., leading counsel for Colonel Brasyer, asked his Lordship if he would set down the action for another hearing, as the jury had been discharged without coming to a verdict with regard to a part of the case.

Mr. Justice Charles said he had carefully considered the matter and he had come to the conclusion that at present he could do no more than enter up the finding of the jury. If the parties wished for a new trial they could, of course, move for it before a Divisional Court.

Mr. Witt then asked his Lordship to make an order that Dr. McCully should be stayed from taxing his costs, in order to avoid difficulty if Colonel Brasyer should ultimately be successful in the action.

Mr. Justice Charles said he must decline to interfere.

Mr. Abinger, on behalf of Dr. McCully, applied for costs.

Mr. Justice Charles: No; there will be no costs.

Latter *v.* Goolden.

This was an action which came before Mr. Justice Lawrance and a jury some days ago in the Queen's Bench Division, to recover damages for an alleged libel, and the defendants in answer pleaded privilege.

Mr. Marshall Hall and Mr. Moore were for the plaintiff, and Mr. Sutton and Mr. Arthur Powell for the defendant.

The plaintiff was a lad who was in his seventeenth year. In June, 1891, he became a junior clerk in the service of Messrs. Goolden and Co., who were electrical engineers, at 8s. a week. He remained there until February, 1892, when Mr. Ravenshaw, the head of the department, gave him a week's notice to leave. The father of the plaintiff was a workman employed in the Royal Mint, and he obtained a nomination for his son as a boy workman in that establishment, and when that situation was obtained the salary would be 15s. a week. The lad passed the preliminary examination, and the only question which remained was that of character, and there were communications between the Civil Service Commissioners and Messrs. Goolden and Co. upon this subject, and the plaintiff did not obtain his appointment. It was known that there had been complaints at Messrs. Goolden & Co.'s as to money having been filched from the pockets of coats that were hung up, and it was believed that what Messrs. Goolden & Co. wrote connected the plaintiff in some way with this misconduct. Under these circumstances the father of the plaintiff wrote to Mr. Ravenshaw, who replied: "Your son is leaving my office as I have no further use for his services. We are getting rid of several boys, having more than we require, and your son not being an apprentice has been included in the list. I shall be glad to give your son a character for neatness and punctuality." The principal difficulty in the way of the plaintiff was to prove the publication of any libel.

A gentleman who was at the head of the department of the Civil Service Commissioners, who had to do with this matter, said that the documents which he was called upon to produce and which was said to be libellous, contained a series of questions and answers in reference to character.

Mr. Hall: I ask you if you will produce that document, so that we may see what was written by Mr. Goolden?

Witness: I decline to produce it, it being confidential.

Mr. Justice Lawrance: That won't do.

Witness: And that it would be against the interest of the public service that it should be produced.

Mr. Hall submitted that great injustice would be done if that document were not ordered to be produced.

Mr. Powell: You have not yet heard our case.

Mr. Justice Lawrance regretted it, but he could not interfere as to the production of the document, for his hands were tied. The defendants were entitled to shield themselves behind this technicality, and there must be judgment for them.

Mr. Hall hoped that at least it would be without costs; there might be a nonsuit.

After some further discussion there was judgment for the defendants, but the question of costs was reserved.

CORRESPONDENCE.

The Electrolysis of Alkaline Chlorides.

Your note relative to "The minimum E.M.F. required in Electrolysis," on page 701 of your issue for June 13th last; another note, on the same page, relative to "Retort Carbons;" the leaderette in your last issue on "The minimum E.M.F. required to decompose Electrolytes;" and the contribution in the same number on "A Point in the Electrolysis of Alkaline Chlorides," are all of interest to those who, like myself, are looking forward to the application of electricity on a large scale to the production of alkali and "bleach." The E.M.F. referred to is, perhaps, the main element which determines the cost of effecting the electrolysis; the question in relation to gas-carbon is, perhaps, of equal practical importance, since it is everywhere admitted that there are but three materials at present available for the anode in the

electrolysis of alkaline chlorides, viz., platinum, gas-carbon, and lithanode.

Your readers have, as indicated above, the best available information as to the minimum E.M.F. required to effect electrolysis under certain normal conditions. But, fortunately, these conditions are not imposed in practice, and, to the practical electro-chemist, it is of great importance to know how far the E.M.F. opposing the electrolysis can be reduced by certain devices which are perfectly intelligible, if not familiar, to him. This must be my excuse for asking you to print the following extract from a paper which I published in June of last year :—

"In any scientifically-devised process for the electrolytic production of 'bleach,' no evolution of hydrogen within the tank would be allowed, not merely because it would bring about the reduction of a large percentage of the hypochlorite formed, but because of the enormous waste of power involved in the liberation of the gas. The latter may readily be absorbed in the reduction of a metallic oxide or oxy-chloride, economically regenerated by heating in air. For a similar reason, any process involving the liberation of gaseous chlorine, or not providing for the generation of hypochlorite within the electrolytic tank, must be regarded as anachromistic when viewed from the present standpoint of thermal chemistry. Without entering into the calculations based on the data supplied by this branch of science, it may be briefly stated that the minimum back electromotive force which, multiplied into current and time, represents the energy expended in electrolysis, exclusive of that converted into heat in overcoming resistance, is as follows :—

	Volts.
(A.) When, in the electrolysis of sodium chloride, hydrogen and chlorine are both liberated ...	2·30
(B.) When hydrogen is absorbed as suggested above ...	1·61
(C.) When both hydrogen and chlorine are absorbed or enter into combination within the electrolytic tank	1·09"

It will be seen that the first value for voltage—that which obtains under what may be termed normal conditions—is in exact accordance with the recent determination by Prof. Oettel. I should be pleased to find the other two values confirmed by the same or by other competent authority.

Perhaps the following conclusions, to which I have been led by a long investigation of the practical problem involved in the electrolytic production of alkali and "bleach," may be of interest to your electro-chemical readers :—

1. Alkali and "bleach" must *both* be obtained, their simultaneous production being an economical necessity.

2. The anode employed must be far less expensive than platinum. It must not be acted upon chemically, either by nascent chlorine or by nascent oxygen.

3. In view of the great expenditure of energy requisite to liberate hydrogen in the gaseous state, this element must be absorbed at the cathode whilst in the nascent state.

4. For the same reason, no chlorine must be evolved in the gaseous form during the process of electrolysis. (It may *subsequently* be evolved as gas, if necessary, by inexpensive means.)

5. The alkali produced must not be traversed by the current; since, otherwise, loss of power is occasioned through the electrolysis of water in lieu of salt.

6. Any hypochlorite (bleach) formed must not be traversed by the current, as, otherwise, it is liable to be wastefully decomposed, both by the current directly and by the heat produces in its passage.

7. The electrodes must be of such form that they can be brought into close proximity, so as to economise space, whilst reducing the resistance of the circuit.

I think that all the above *desiderata* can be realised in a practical form.

Desmond G. FitzGerald.

Variation of Electric Pressure.

Mr. Hesketh, in your last issue, really confirms the results mentioned in Mr. Chew's paper. That the occurrence was a local one, and that the station records show no such variations, prove both that Mr. Hesketh is not personally responsible, and also that the fault lies with the designer of the system.

What is required in a station is that the engineer should be able to know at any instant the pressure on the house side of the transformers, and be able, by means of feeders and regulators, to maintain that pressure as near constant as possible. The voltmeters at Blackpool simply indicate *station pressure*, which is a very different thing to *consumer's pressure*.

As the pressure is the only evidence a consumer has of an efficient supply, every other point in a station should be made subservient to that of maintaining such pressure constant.

M. S.

July 17th, 1894.

Tumbler Switches.

I am neither a manufacturer of a tumbler switch, nor do I blame a patentee who *has* invented a valuable improvement in any article, to try and secure to himself the fruit of his research. But what I cannot understand is a company, whose catalogue is a living contradiction of the ethical maxim expounded in the closing sentence of their letter in last week's Electrical Review, posing as the champion of electrical engineers' sweated brains and pockets. The motto, "Act according to my words, and not according to my deeds," would have been most appropriate at the head of the General Electric Company's reply.

Sweated Brain.

July 11th, 1894.

Alternate Current Distribution.

In the somewhat hasty letter of mine you publish in your last issue, I see that I have fallen into the error of ascribing Mr. Lowrie's patent to Mr. Geipel, and of omitting mention of Mr. Lowrie altogether. My apologies are due to these gentlemen for this, and also for appearing to state that their inventions are anticipated by Mr. Swinburne's. The suggestion to use separate primary circuits did, I believe, originate with the latter, but, as far as I can recollect, his specification contains little else but the bare suggestion, and cannot be said to cover the very practical and complete methods that have been elaborated by Messrs. Lowrie and Geipel.

In answer to Mr. Thompson, I may say that I do not fail to appreciate the particular advantages of methods based on these lines. In fact I consider them a considerable advance, in point of reliability of working, upon the complete automatic systems. Not only must the absence of switches on the primary side contribute to this, but, through the extra primary circuit absolute and immediate information can be obtained at the central station as to the working or failure of the mechanism. For the ammeter on the circuit will show at once if the secondary switch has gone on as it should do; particularly if, for the purpose of the test, a little extra voltage be thrown on the circuit; and a voltmeter across the station end of the circuit would indicate clearly if the secondary switch failed to go off. Guided by these indications, the mechanism may be humoured by switching the primary circuit on and off a few times, and if this fails, an attendant could be despatched to the spot as a last resource. And they have at least an advantage in point of convenience over the method of hand switches and itinerant attendants.

My objection to them is because of the use of *any* moving mechanism under the conditions to which the transformers are subject, and the necessity this creates for the provision of means of ready access. Further, the range of control obtained is very limited, and on the top of an extra expenditure for mains, there is the cost and uncertain maintenance charges of the switching mechanism. They have, I should add, some strong and capable competitors in the pilot wire methods of actuating the switches — Mr. Parker's, for instance.

In the above remarks I have bracketed Messrs. Lowrie and Geipel's schemes together, as they are practically equivalent one to the other. The distinction between them is in the arrangement of switches. Mr. Lowrie's scheme, as des-

cribed in his specifications 3,666 and 22,131, of 1893, includes a very ingenious type of switch in which the primary current is not used at all, the operation being effected by the change of direction of the flow of energy from or to the transformer. Thus when the supply is cut off from the primary circuit the direction of the energy flow on the secondary side is reversed, coming *to* the transformer instead of *from* the transformer. Advantage is taken of this reversal to switch off the secondary; to switch it on, a very pretty application of the repulsive force between induced and inducing currents is made. The switch proper would, I suppose, be connected to the swinging limb of magnet by a tappet arrangement, so that it is struck on and off; it should not be difficult, therefore, to get a sufficiently powerful blow.

Mr. Geipel's scheme includes a relay on the primary circuit, used to open and close a shunt circuit on the secondary mains which operates the switch. He intends the system to be used as part and parcel of the system of "sectionising" mains, patented by himself and Mr. Raworth. Its correct number is 6,666, 1893.

I will endeavour to give the further explanation of my system you require, in your next issue.

J. Whitcher.

New System of Ship Wiring.

I am pleased to find that the system of wiring *La Marguerite* meets with such universal approval; but I was not aware that it had been carried out by any other firm before the publication of the numerous letters in your Journal, nor that I had unknowingly followed the lead of Messrs. Siemens Bros., but I might advise some of your correspondents to follow their example, both as regards good work and letter writing.

Considering the trouble your Journal some time ago took to ventilate the subject of jerry wiring of ships, I must say that it surprises me that not one word was then written to you to direct the straying sheep, and I certainly think great credit is due to you for being the first to point out the way to the majority of your readers.

In respect to Prof. Andrew Jamieson's letter, I believe I am not mistaken in saying that he acts as a consulting electrical engineer; if so, I would respectfully point out to him that in future, if he wishes the vessels for which he writes out the specifications to be wired on the plan of *La Marguerite*, he will avoid such loose wording as "multiple main," "multiple branch," and "double wire system," otherwise he would not get it, as I could comply with that specification absolutely, and yet have joints made all over the place. I note that the number of vessels wired on this plan to his specification are not given in his letter, as is done by Messrs. Siemens Bros., and I might here add that by the use of omnibus bars this system is applicable to concentric wiring.

I do not see how Mr. Ronald A. Scott, who admits only making switches and distributing boxes according to instructions and patterns supplied by the Admiralty, can form any opinion on the question of the amount of wire used. I can only tell him that my experience is as stated in your article.

In your article (July 13th) you ask me if I can help you in settling the question of priority, and on this subject I am reminded of an amusing experience which occurred to me at the Paris Electrical Exhibition, when a gentleman of the name, so far as I remember, J. Banting Rogers, exhibited a hollow ball which, if connected to a 10-light dynamo, would, as he said, give you another 10 lights, and if you bought more of his balls, I believe he went so far as to say you could go on increasing *ad infinitem*. He had a place afterwards on Holborn Viaduct, and I think you had something to say at the time on his system. His system was to bring a main wire from each terminal of a dynamo, and connect each to a hollow ball, and from these balls, under the heads of screws that were inside, he led a wire to and from his incandescent lamps, each on a separate circuit. If he wanted another 10 lights he took another large lead, and connected another two balls, and from these he got 10 more lights; but I fancy there was trouble in the engine room.

N.B.—Your correspondents appear to have overlooked the fact that the system of wiring adopted on *La Marguerite* is only satisfactorily worked by a Siemens or Mackie dynamo.

W. Mackie.

Electric Lighting Specifications.—We have received a letter from "An Installation Foreman" in reply to "Ex-foreman," which, we regret, we are unable to publish on account of its length. Correspondence on this subject must now close.

Alternate Current Distribution.—We are compelled to leave over two letters on this topic, which arrived too late for insertion.

THREE MUNICIPAL ELECTRICITY SUPPLY WORKS.

DERBY.

In many respects the Derby Corporation station is one of the most interesting in the country. There is a combination of the old and new which of itself bespeaks the care and attention bestowed upon the work. The history of Derby lighting is a brief one; it goes back to 1890, when, to protect the town interests from rapacious electric light companies, the Corporation secured a Provisional Order. The municipality, however, went farther than to merely defeat the objects of private enterprise. It was felt that the town might with some success introduce the lighting, and in furtherance of this feeling Messrs. Bramwell & Harris were asked to prepare a report. After this there was a good deal of delay, not altogether unavoidable, but finally the Electric Lighting Committee, after an exhaustive consideration of the report, recommended the Council to borrow £30,000 for the purpose of providing a system of electric lighting. In 1893, the Corporation asked for tenders, it having been decided to build works on a site in Silk Mill Lane, now known as Full Street. Having settled on the tenders, the work was pushed on with pleasing and commendable rapidity, and in October of last year the station was formally opened. Since that time there have been, of course, considerable extensions, but now that these are practically complete it will not be out of place to attempt a description of the work.

The System.

Briefly, the system combines a high-pressure alternating current (2,000 volts) for private lighting with a high-pressure continuous current for the street lamps. The alternating currents are supplied by a number of leads to transformer sub-stations, these in turn supplying a transformed current into what is termed a ring main from which consumers take their supply. A specially novel feature about the alternating current is that the low frequency of 40 is used. Nothing as low as this has been hitherto used in England; though indeed, the experience gained from Continental practice has been distinctly in favour of such low frequency.

It has been found, however, in Derby, that this low frequency, even when used for arc lamps in interiors, is in no way objectionable by reason of flickering, though, of course, the defects of a low periodicity are not so manifest in incandescent lamps and isolated arcs. It will be seen from our illustrations that combined plant is used throughout the station, both alternators and continuous current machines being direct coupled. Some idea of the arrangement of the plant will be also obtained from the illustrations. Before passing on to describe the plant in detail, we would mention that parallel running of the alternators is adopted whenever the load renders the use of two machines necessary.

The Steam Plant.

There is nothing unusual or specially interesting in the boiler house, in which there are three Lancashire boilers except, perhaps, the arrangement of Vicars's mechanical stokers and elevator, in some respects similar to that employed at Portsmouth. The boilers are made by Messrs. Fletcher & Co., of

Derby. As we have mentioned, they are of the Lancashire type, with Galloway tubes, and work at a pressure of 120 lbs. per square inch. From the boilers a ring main steam pipe passes underneath the engine house, the steam passing through two steam separators, and branches are taken from the ring main to each engine as they are required. The exhaust from these engines is carried either direct to the atmosphere or into a surface condenser which is placed in the basement with the necessary air and circulating pumps of the Worthington type. This pump draws the circulating water for the condenser from the river Derwent, which adjoins the works, and delivers its hot water into the hot well on the top of the boilers, from whence it is pumped again into the boilers, as required, by a small donkey pump. The mechanical stokers and their feeders are driven by two small engines situated upon the top of the boilers, one being sufficient for the work, the second being a spare one. Passing on in the order of things we come to the engines which are exceedingly good specimens of their class. There are two or three novelties about them which have never been described in the Electrical Review, so we give a detailed account.

The plant is divided into four sizes or units, viz.: 13 H.P. for exciters, 35 H.P. for arc lighters, 50 H.P. and 100 H.P. alternators for incandescent lamps, there being three sets of engines and dynamos of each size.

The exciter sets each consist of a Siemens direct current dynamo coupled to a Browett & Lindley single-cylinder vertical engine, the diameter of cylinder being 7 inches. They have a 6-inch stroke and run at 300 revolutions per minute. They are fitted with patent automatic shaft governors giving great steadiness of running. A notable detail also is the use of the "Abercrombie" patent self-adjusting connecting rod bolts, by which wear at the crank-pin bearing is taken up automatically as it occurs, and silent running is obtained.

The 35-H.P. arc lighting set consists of vertical compound engines with steam-jacketed cylinders, 6 inches and 10 inches diameter by 8 inches stroke, running at 300 revolutions, and coupled direct to a Siemens direct current machine adapted for running arc lights in series. These engines are fitted with automatic shaft governors, patent self-adjusting bearings to crank pins, and with the usual accessories for securing long runs. Amongst these may be mentioned a complete arrangement for continuous oiling from central oil boxes, each pipe being served by an adjustable sight drop tap, made so that the supply can be shut off without altering the adjustment.

The 50 H.P. sets consist of vertical compound engines with cylinders 7½ inches and 12 inches diameter by 9 inches stroke, coupled to a Siemens's alternator, the speed being 240 revolutions per minute. The 100 H.P. sets consist of vertical compound engines having cylinders 10½ inches and 18 inches by 12 inches stroke and running at 200 revolutions per minute, each coupled direct to Siemens's alternators.

The Electrical Plant.

Coming to speak of the electrical part of the combination, there are three sets of what may be termed the public lighting plant. The machines are Siemens H.H.D. type of dynamo, which give 10 ampères at 1,800 volts for working a circuit of 40 arc lamps. Each of these machines has a ring armature revolving in a double magnetic field, and is provided with a regulator which automatically varies the E.M.F. in proportion to the external resistance and thus maintains the current constant. The required adjustment is effected by shifting the position of the brushes on the commutator relatively to the neutral line. For this purpose, the shaft of the dynamo works by gearing a crank which causes reciprocation of a rod guided through a sleeve, this rod being connected to a lever jointed to the core of a solenoid. The coil of the solenoid forms part of the main circuit, and, as the current varies in the circuit, the core of the solenoid is moved more or less in opposition to the force of gravity so that the reciprocating rod is thus moved in the one direction or the other. The motion of the core can be adjusted by means of a balancing weight and spring attached to the lever. Surrounding the rod is a pawl-shaped collar, which, according as the rod is moved to right or to left, engages the teeth of a ratchet wheel, one of which is mounted on each side of the rod. The spindles of both ratchet wheels carry pinions which are connected through gearing to a ring mounted concentric with the axis of the dynamo. On this ring is held by spring friction the rocking frame which carries the brushes, the movement of which is as usual limited by stops.

When, owing to movement of the solenoid core resulting from variation of current in the circuit, the one or the other of the ratchet wheels is partly turned by the action of the reciprocating rod, the ring and with it the frame carrying the brushes is partly turned so as to move the brushes more or less to or from the neutral line, thus varying the E.M.F. of the dynamo so as to compensate the resistance in the circuit, and give constancy of current. As the brush frame is held to the ring only by friction, it remains at rest against either stop, notwithstanding that the ring may be moved farther.

For the private lighting, pure and simple, special plant has been set apart which consists of three combined engines and alternators, each of an output of 60 kw. at 2,000 volts. In addition are three smaller combined sets, each capable of giving 30 kw. at 2,000 volts. The alternators are of the usual type with revolving disc armature and fixed field-magnets. The direct coupling of an alternator to an engine

Derby Lamp Pillar and Transformer Box.

running at so low a speed, the alternators being wound for such a low periodicity, is a novelty, and we take the opportunity of giving an illustration of the set. The exciting plant consists of three combined sets. An extension plant of 250 H.P., similar in design to the 100 and the 50 horse-power sets, is being erected at the present moment.

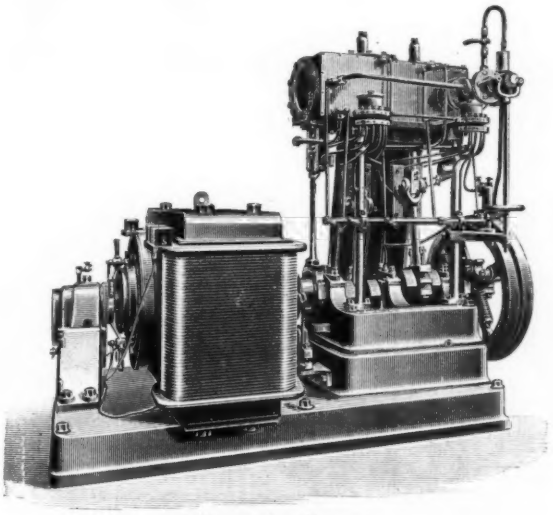
The Switching Arrangement.

The main switchboard, which we illustrate, covers a corner of the engine room; it is composed of panels of enamelled slate (one for each engine) and the others for the feeder mains, fitted into pitch pine moulding or framing. No. 1 panel contains ammeters, voltmeters, main switch and fuses for the arc lighting, the other panels containing the necessary measuring instruments for the alternating current machines. Each panel of the switchboard has main switches and

fuses controlling the feeders, the synchronising switches being also on these boards. Along the front of the switchboard is a platform which stands some 6 feet 6 inches above the level of the room. From this platform an uninterrupted view of the station is obtained.

The Distributing System.

The mains pass from the switchboard to twelve central points in the town. In convenient spots at these centres, a cast-iron sub-distributing transformer box, somewhat similar to an ordinary pillar letter box, is placed, upon which is mounted an arc lamp for street lighting. These mains enter the box, and after the current is transformed from 2,000 volts to 100 volts, it is distributed to the consumer by mains placed in 4-inch earthenware pipes running about 18 inches under the pavement. At convenient points drawing-in boxes are placed in these length of pipes. The feeders to the transformer sub-stations are concentric, each conductor being 0·0352 square inch section insulated by a specially prepared fibrous material to withstand the 2,000 volts pressure; they are also cased with lead, served with jute, and armoured. They are laid directly in the ground, at the present time there being about six miles laid. The distributing mains from the transformers are a single conductor 0·0428 square inch section insulated with India-rubber and braided. As we have mentioned, they are drawn into 4-inch earthenware pipes, and there are at the present moment about 13½ miles laid. There are 8 21-kw. and 6 10½-kw. transformers, which are placed in the cast-iron boxes forming the bases of the lamp-posts above referred to. The switch gear is always placed in an entirely separate underground box, with flush cover opened by key.



A Derby Arc Lighter.

A complete continuous record is kept at the lighting station of all the current supplied, and the condition of the supply at the consumers' premises at all times is noted. All the transformer boxes are coupled up in ring formation on the distributing mains, so that should it become necessary from any cause to isolate one box or transformer, other boxes will supply the necessary current to any particular district. Other mains, for the public lighting of the streets, pass out of the station and along by the same route as the mains for the private lighting, one of these two mains being on one side of the street, and one on the other. These mains are so arranged, that at any time one half the street lamps can be worked independently of the others; that is to say, every alternate lamp in the street is lighted from one main, the other main supplying the remaining lamps.

Many lamp-posts have curved drooping tops and suspended lanterns, others being straight posts with lamp in curved supporting arms. We give an illustration of one of this latter type, the centre of lamp being 30 feet from ground line. The arc lamps are of the Siemens band type. The lamps each take a current of 10 ampères at a pressure of 45 volts. These lamps and posts are, to a large extent, erected on the side-walks, as the Derby roadways are generally too narrow to allow of the lamp-posts being placed in the centre of the roadway. The height to the centre of the lamp is 22 feet from the pavement level.

The mains from the switchboard to the sub-distributing transformer boxes before-mentioned are known as concentric, lead-covered, and steel-armoured. They are laid directly in the ground, as are the arc or public lighting mains, which are similar in construction, but smaller in cross-section.

The distributing mains are vulcanised India-rubber cables, and are drawn into the earthenware pipes before referred to as and where the demand for current arises.

The pilot wires are similar in construction to the distributing mains, but are smaller in cross-section. These are also carried in the earthenware pipes.

The Prospects of the Undertaking.

The success of the undertaking was never for a moment in doubt. The townsmen were, from the commencement of the works, keenly interested in the enterprise, and many showed their practical sympathy by becoming consumers. The most satisfactory feature, too, about the consumption is, that consumers were not astonished at the end of the first quarter, as is so often the case, by the amount of their bill, but in many cases were agreeably surprised at the low cost, and many of the consumers declare that the cost to them of electricity for the quarter to March 31st last was less than the corresponding quarter for last year, that they had had much more light and greater comfort and cleanliness. Naturally, with gas at 2s. 8d. per 1,000 feet, only a low price for electricity could be charged, and 6d. per unit is the price for lighting and 3d. for cooking and power purposes.

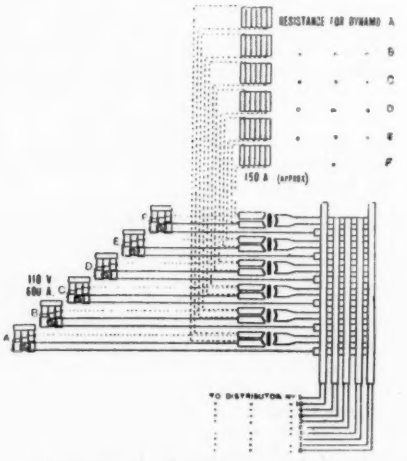
The resident engineer is Mr. J. E. Stewart, and his assistant is Mr. Ford Moore, the works having been designed by and erected under the direct supervision of Messrs. Bramwell & Harris. Before concluding this article, we ought to mention that, though young, the undertaking has been pre-eminently successful. The amount received for current from the opening day, October 10th, 1893, to March 31st last, with an average taken over the whole period of only about 1,500 8-C.P. lamps connected, was £474 7s. 10d., the average income of each lamp for a period of five months being 6s. 6d. Of course the period is the best in the year for lighting, but still the fact is interesting when we consider the youth of the undertaking.

MANCHESTER CORPORATION WORKS.

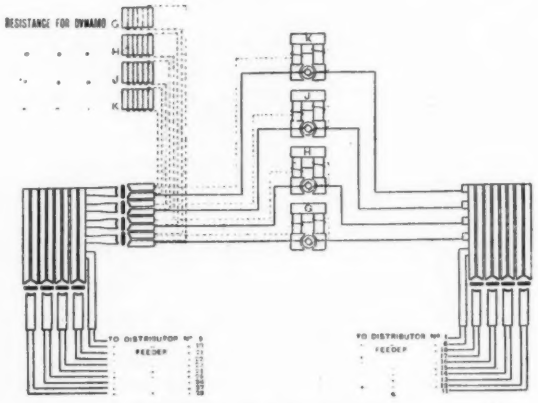
What we may fairly term the Manchester system involved so much that was different from generally accepted practice, that we judged it better to have some experience of its working before saying much about it. The system has been now in use some nine months, and has been a complete success. It was never expected that the introduction of a five-wire scheme into Manchester would be attended with unalloyed success, but the promoters of this system have had few difficulties to meet, and these were merely troubles incidental to all new electric light undertakings; nothing seems to have arisen that could fairly raise the question of the utility of the five-wire method. We may look upon the five-wire system as an attempt to combine the advantages of a high and low pressure system without the intervention of a transforming apparatus pure and simple. But, under certain conditions, it has obviously its disadvantages, the chief of which are the great complications usually arising in the arrangement of the mains and the regulating devices. Besides there must be always more or less objection to introducing high pressures into a consumer's premises. These defects, however, are entirely avoided at Manchester, two pairs of motor-generators do all the regulating, and the pressure between the consumers' wire and earth does not exceed 200 volts. It would be impossible for us at the present moment, however, to enter further into the merits and demerits of the system, for the question would necessitate a fair and ample discussion of all methods of distribution. At its best it possesses unquestioned advantages, and it is to be sincerely hoped that the originators will, when the opportunity arrives, raise the important point as to whether the Manchester system constitutes an advance on other methods of distribution.

Perhaps the best known application of the five-wire system

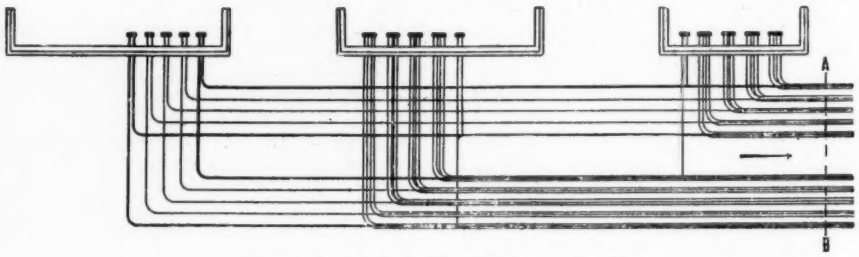
is at the Rue de Clichy, Paris, where such a method has been now employed for five or more years with a fair amount of success. This instance, which we believe is almost the first, is too well known to be dwelt upon. The method employed at Manchester, however, differs in some respects from that of the Rue de Clichy. Four 100-volt machines are arranged in series, 400-volt machines being employed for the main supply. As we have already indicated, the outside wires of the Manchester system have a difference of potential of 400 volts, the inner wires having between each other a pressure of 100 volts. These inner wires are practically the return or balancing wires. The five wires are fed at a number of points throughout the area of supply by means of heavy



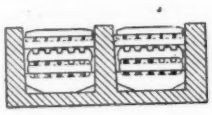
Arrangement of Compensating 100-Volt Machines



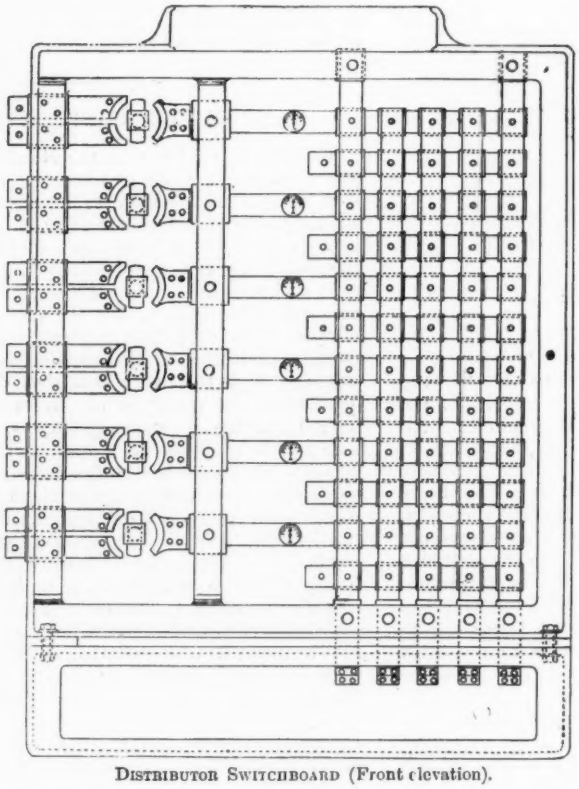
Arrangement of 400-Volt Machines.



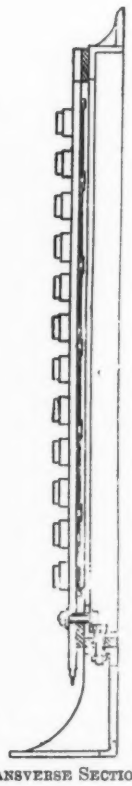
Plan of 'Bus Bars, with Feeders and Distributors.



Section of Conduit at A, B.

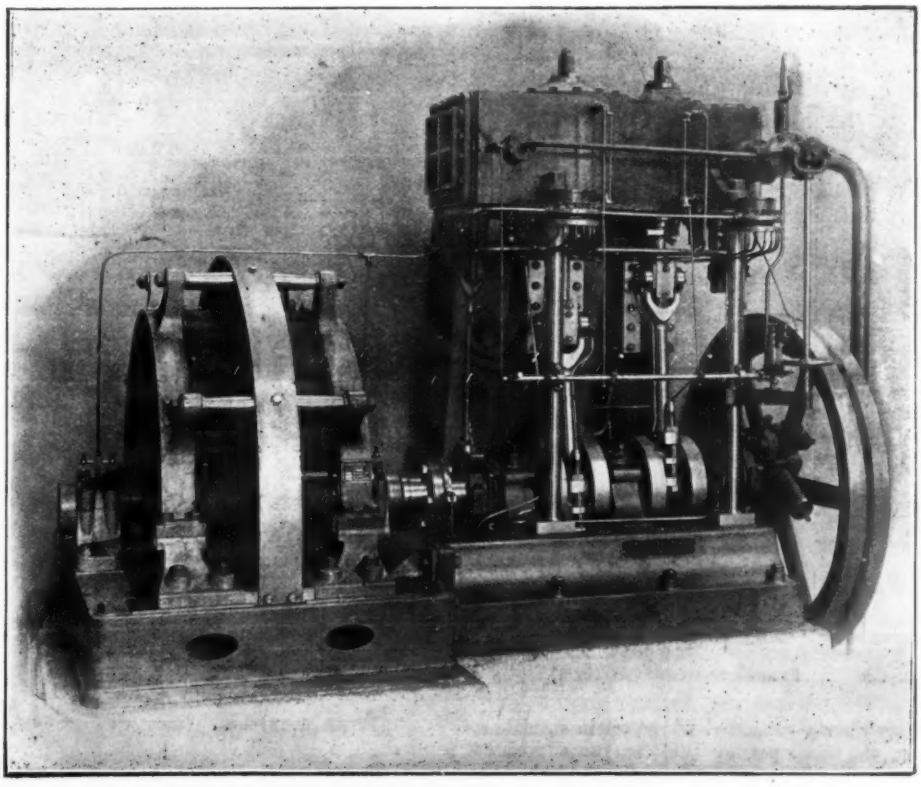


Distributor Switchboard (Front elevation).



Transverse Section.

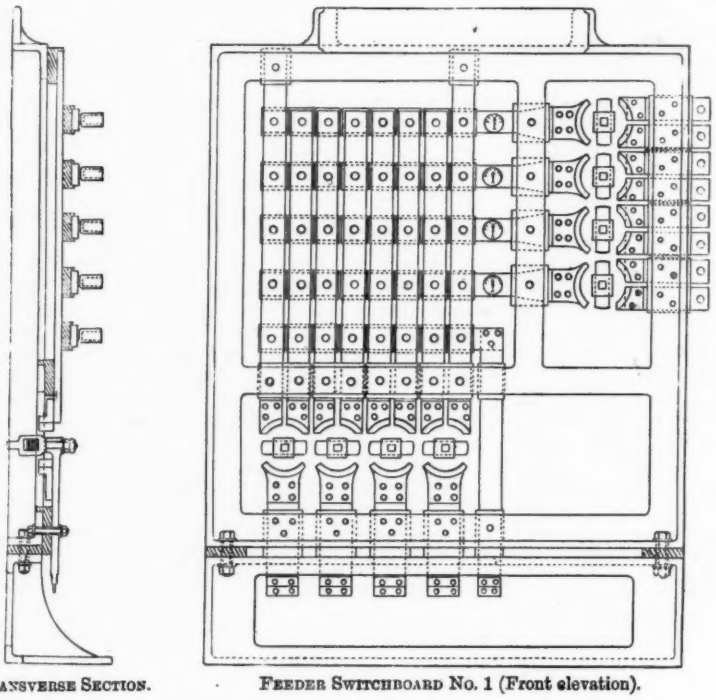
Laying the Mains at Derby.



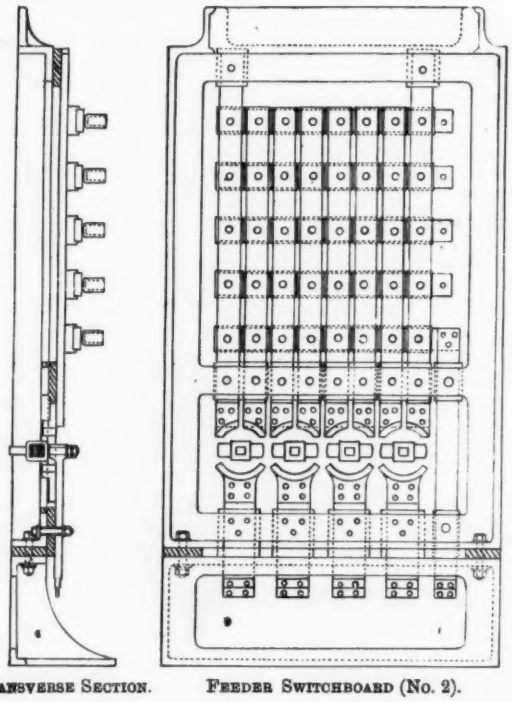
View of Combined Siemens Alternator and Browett and Lindley Engine at Derby.

feeders, the main supply being derived from the large dynamos, though the balancing dynamos besides their compensating functions can also supply power to the feeders. For this purpose they are placed on to the various sections of the system and are not coupled to the feeders. Some idea of the arrangement of the machines will be obtained from the diagrams.

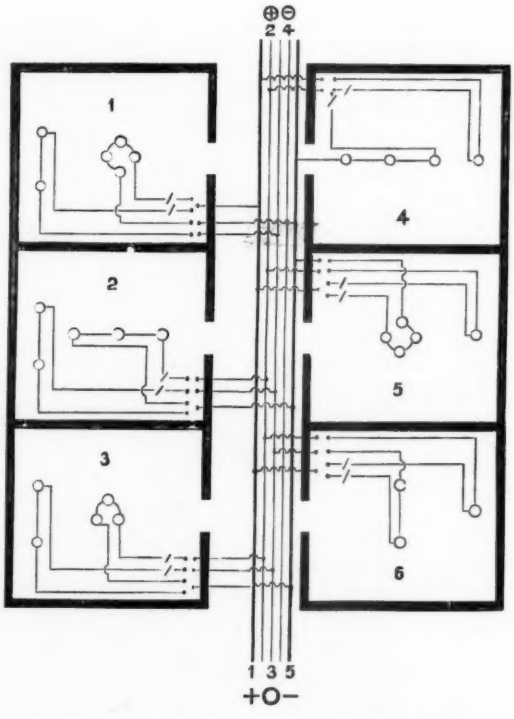
For the most part the mains, both feeders and distributing,



Transverse Section. Feeder Switchboard No. 1 (Front elevation).



Transverse Section. Feeder Switchboard (No. 2).



Plan of Interior Wiring on Five-Wire System.

are of bare copper strip supported on porcelain insulators. Where, however, the mains pass under the roadways insulated cables are employed. This, however, is not the only consideration which led the engineers to adopt insulated cables. for we believe that for the smaller cables, one square inch sectional area and under, it has been found to be more practical and economical to use insulated cables. The India Rubber Company have supplied ½-inch and ¼-inch, besides the necessary smaller cables for branches, the types adopted being cables insulated with pure rubber, then vulcanising rubber, special tape, and the whole vulcanised together: then braided flax and taped canvas over all, then coated preservative compound, the cables being differently coloured—to allow of their being easily distinguished one from the other; the minimum insulation tested in water after 24 hours immersion at 60 degrees Fahr., and one minute's electrification being 2,500 megohms per mile. These cables are drawn into iron pipes in the usual way.

The Engines.

The engines in use at Manchester are very fine specimens of their particular class. There are four large ones and six smaller ones used for balancing purposes. The four large ones, which are by Galloways, are of the compound vertical type, each having high-pressure cylinders 17 inches diameter, and low-pressure 34 inches diameter, with a stroke of 3 feet. The pistons from these cylinders work on to crank pins placed at each end of a crank shaft, which carries the fly-wheel acting as a pulley, being turned and crowned for receiving link belt, which transmits the power direct to the dynamo, and as these dynamos are in close proximity to the engines, jockey pulleys are provided for the purpose of maintaining the requisite tension on the belt. As the engine cranks are at right angles, a receiver between the two cylinders is necessary, and both cylinders with this receiver are steam jacketed, the steam for this jacket being derived from the boilers direct. The variation in speed is effected by Galloways' patent high-speed parabolic governor, specially arranged so that its sensitiveness and speed can be easily altered while the engine is running. The engines are intended to work at a pressure of 120 lbs. on the square inch, and to develop 400 horse-power each when running at a piston speed of 500 feet per minute; they are also arranged to run faster if required. The steam is condensed not by the ordinary jet or surface arrangement, but by Korting's ejector condensers placed in close proximity to the engines. These ejectors are supplied from a tank placed over the boiler house, which is supplied from the canal by means of powerful centrifugal pumps worked by independent engines, the fall of the water condensing the steam, all being carried away without the necessity of an air pump.

The six small engines are vertical tandem compound condensing engines, working at a steam pressure of 120 lbs. at 120 revolutions per minute. These are made by Richard Hornsby & Sons. The high-pressure cylinder is 10½ inches diameter, the low-pressure cylinder is 16 inches diameter, and the stroke is 2 feet. There is a massive bed-plate which carries the crank-shaft, and on this is a vertical cast-iron frame at the back, and two wrought-iron columns at the front which supports the low-pressure cylinder. At the top of the low-pressure cylinder, at a sufficient height, so as to be easily able to get at the glands, is mounted the high-pressure cylinder. The slide of the low-pressure cylinder is on one side of the engine, whilst the high-pressure slides are on the other, the former being adjustable, the latter consisting of two slides, one being an automatic cut-off which is regulated by the governor. The governor is of the Porter type, and controls the speed of the engine most efficiently. The engines are supplied throughout with all the necessary lubricating arrangements, so that they can be run continuously. The condenser is of the Ledwards automatic type.

The boilers, by Galloways, are 30 feet by 8 feet, and work at 125 lbs. pressure, and are provided with very complete fittings, including Vicar's mechanical stokers. A very unusual feature in the boiler installation is the duplicated arrangement of the entire ranges of steam and feed pipes, in fact, the duplication is so complete that under no possible combination of circumstances can the whole of the boilers or engines be rendered inoperative. The steam pipes are of large size, 18 inches diameter, and are all of wrought-steel welded, with strips double riveted over the weld.

A Green's economiser is used, which consists of 576 tubes, arranged on the most approved principle in six groups of 96 pipes each, coupled together with copper expansion elbows between the spaces, thus allowing free and easy access to all parts of the economiser. Being in two divisions of three blocks each, the economisers can be worked separately if desired, *i.e.*, by closing the dampers leading to either of the three blocks and working through the other three. This method effectually provides for emergencies, such as repairs or cleaning operations, without stopping the whole of the apparatus and so losing the benefit of its saving properties.

The arrangement of flues being one of the best, a very satisfactory result is being obtained at the Manchester station, the natural consequence being that the saving effected will quickly repay initial outlay. By this arrangement provision is also made for extension of economiser as it becomes necessary to enlarge the existing boiler plant. The gearing of economisers is driven by a small horizontal high-pressure engine fixed between the two economisers.

The Dynamos.

The dynamos in use are among the most striking features of this unique station. The types are nothing unusual, but their proportions are what one seldom sees. At the present moment there are four 240-kilowatt machines working, but at the time of writing the foundations are being prepared for a fifth. Of these large machines, two have been supplied by the Electric Construction Corporation and two by Mather and Platt. The former are of the well-known Elwell-Parker type and are designed for an output of 590 ampères at 410 volts when running at 400 revolutions per minute. In addition to these, this company has also supplied the six smaller machines which give 590 ampères at 102 volts at 540 revolutions per minute.

The two large dynamos supplied by Messrs. Mather and Platt have been constructed to give a similar output to the large machines just mentioned. Like the others they are both intended to work on the feeders of the five-wire system. These machines are of the "Edison-Hopkinson" type and are shunt wound with armatures internally ventilated and wound with stranded bars. The resistance of the armatures is ·0117 ohms, and of the shunt coils 52·7 ohms, the electrical efficiency is stated to be at full load 97·2 per cent., and at half load 95·9 per cent. In accordance with the contract the machines were officially tested to determine their commercial efficiency, the method of testing being a modification of Dr. John Hopkinson's original motor-generator system, in which the loss in the combination is supplied by a third dynamo placed in series with the armatures of the two machines to be tested: the advantage of this method being that all the measurements are electrical, and that even a considerable error in the measurement of the output of the machines cannot cause any error of any importance in the final result.

By a series of very careful tests it was proved that the efficiency for the double conversion from electrical into mechanical power and back again of each machine is 90·5 per cent. Hence, the commercial efficiency of each machine is 95 per cent. and the efficiency of conversion 97·7 per cent.

Each of the dynamos, as we have already mentioned, is driven from a vertical compound condensing engine by means of a link leather belt, a separate stand with jockey pulley being provided, so that a short drive might be used and space economised.

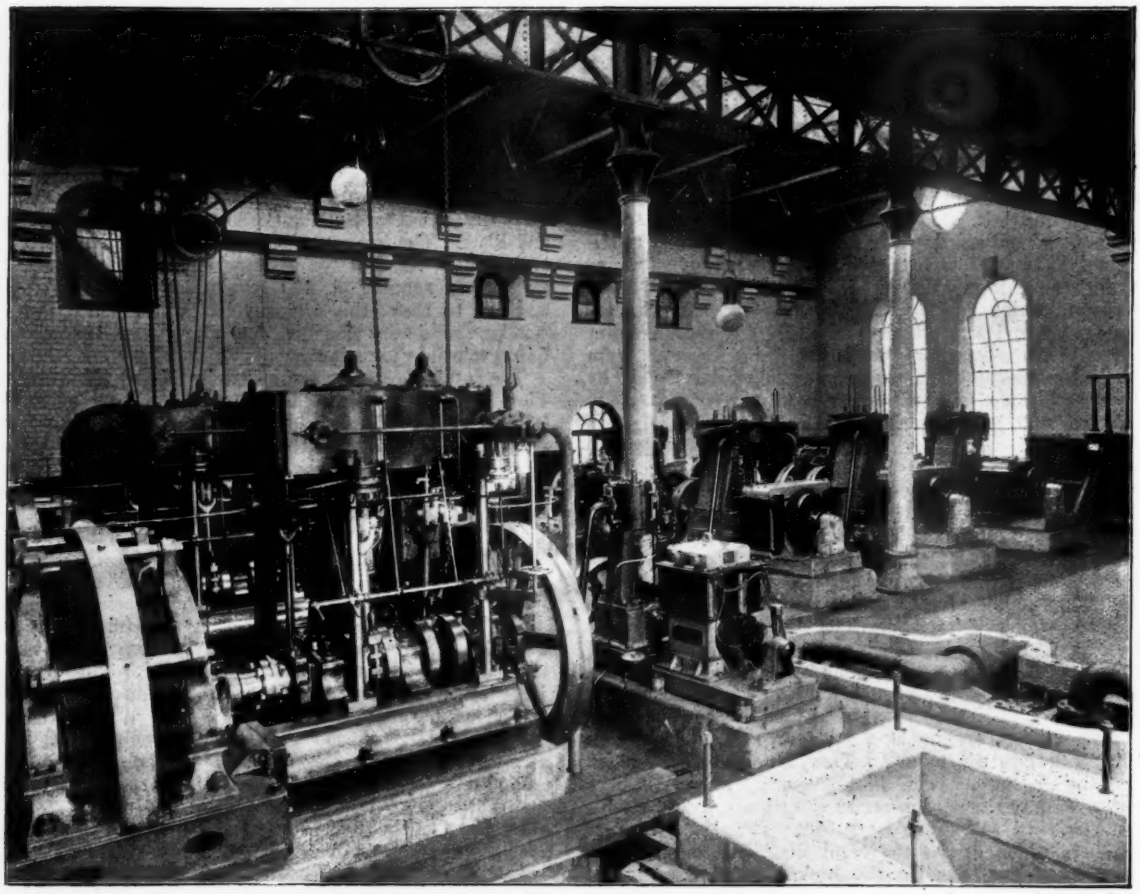
The four motor-transformers used for transferring 100 ampères at 100 volts from any one circuit of the five-wire system to any other, are also of the "Edison-Hopkinson" type. They are designed for running continuously at a speed of about 1,400 revolutions per minute, and are at present fixed in the engine room.

Before passing on to the switchboard we might mention that an electrical crane is used for unloading the coal barges which come up the Manchester and Rochdale canal alongside the boiler house, the coal boxes, each weighing about two tons, being lifted from the boat and unloaded direct into the hoppers of the mechanical stokers. In addition to this application of electrical power we will point out that the engine house is ventilated by a Blackman air propeller driven by a 2-H.P. "Manchester motor." Air is also forced into the main conduits by a Belliss fan driven by a "Manchester" motor.

The Switching Arrangements.

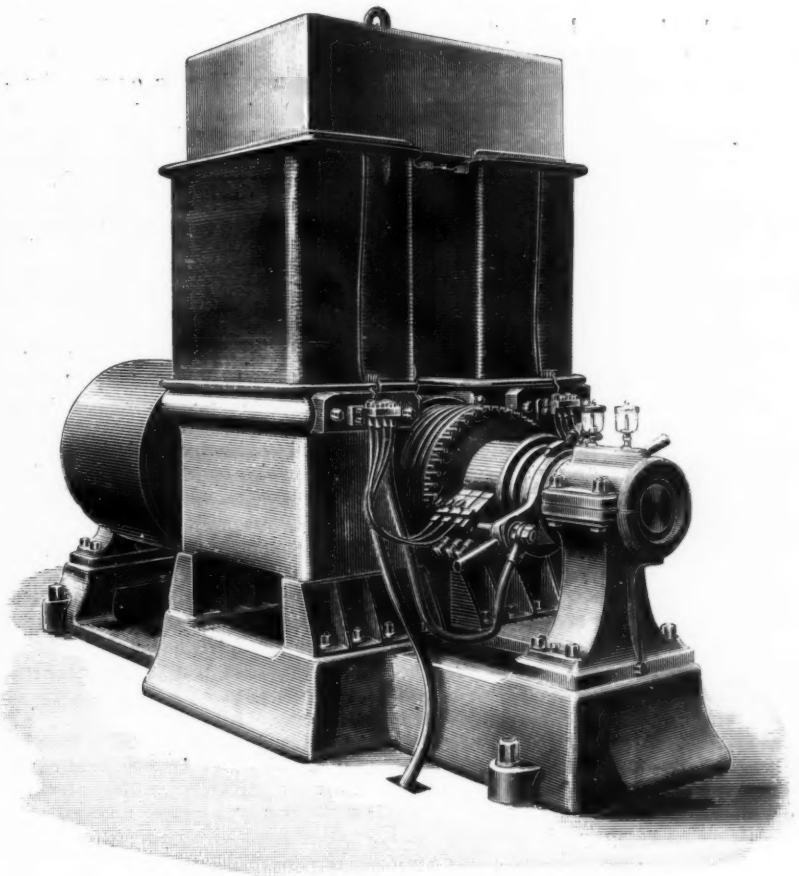
Considering that the system is to some extent complicated, it is a trifle surprising to find the switchboard almost a model of simplicity. By the courtesy of Messrs. Mather and Platt we are able to give diagrammatic sketches which show the arrangement of the switches.

The main switchboard is of a distinctly novel type, and is specially designed for convenience of extension, the whole board being divided into three separate boards, viz.:—Nos. 1 and 2, "feeder" boards, and No. 3, "distributor" board. Each board consists of a cast-iron frame, upon which are mounted vertical and horizontal bars of high conductivity gun-metal. These bars are insulated from one another and from the frame by porcelain insulators. The horizontal bars are connected to the dynamos in all cases, and the vertical bars to the feeders, or distributors, as the case may be. On

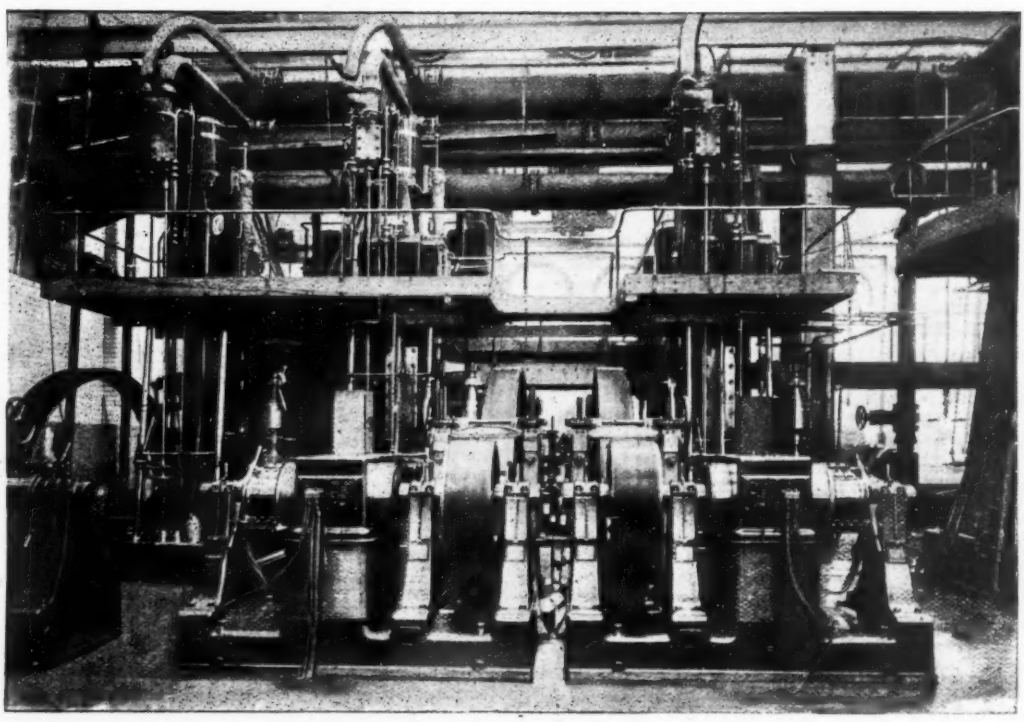


View of Derby Central Station.

Derby Switchboard.

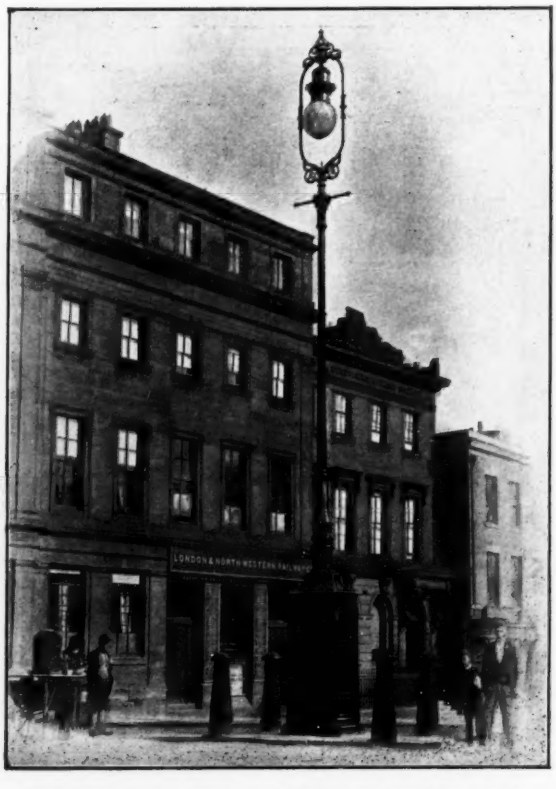


One of the Mather & Platt Machines at Manchester.



A View of Engines and Dynamos at Manchester.

No. 1 feeder board and the distributor board the connections from the dynamo to the bars are made through specially designed switches, fitted with substantial laminated copper brushes or tongues, mounted on a steel centrepiece with



A Derby Street Lamp (The base used for transformer box).

detachable key. The feeders on both Nos. 1 and 2 boards are connected up to the vertical bars by means of switches similar to those connecting the dynamo mains to the boards. The connection between the vertical and the horizontal bars is made in all cases by means of screwed plugs passing through clearance holes in the upper bar and screwing into the lower or horizonnal bar, the contact being made with the upper bar by a collar cast on the plug. A spare vertical and horizontal bar are left on the boards, Nos. 1 and 2, so that the feeders can be connected up to the distributor board and dynamos in case of light loads, thus avoiding running the larger dynamos. The outgoing mains from the "feeder" dynamos are taken direct to the switches on the horizontal bars of No. 1 board. These switches are designed and arranged so that any feeder dynamo can be used as a motor worked from the mains to start its engine and itself, by having two points to the switch, one of which is connected to the dynamo through a resistance which is switched out when the dynamo has attained its proper voltage. The feeders are taken from the lower point of the switches on to the vertical bars, the other two points of each switch being connected to separate bars. The change over of the feeder from one dynamo to another is effected by inserting a screwed plug through the vertical feeder—which is clear of the switch tongue—into the horizontal bar of the dynamo to be connected, and the feeder switch turned so that the new bar makes contact with the switch tongue. The return feeders are connected to a separate board, similar in all respects to the above, with the exception that there are no dynamo switches.

In the distributor board the horizontal bars are connected to the smaller dynamos, the positive mains through two-way switches, with a resistance as described in connection with the feeder board.

On these horizontal bars are placed the "current indicators," consisting simply of a loaded compass needle and graduated scale, which serve to indicate the approximate amount of current passing.

The distributors are connected direct to the lower ends of the vertical bars, without the intervention of switches, the changing over of a dynamo to a distributor other than that to which it is already connected being effected in the same manner as described for the feeders.

Interior Wiring on the Five-Wire System.

Before leaving the subject of the Manchester system, we should like to dwell briefly upon the nature of interior wiring on a five-wire system. As an example, we have taken the Manchester Town Hall, and though this is the largest building which is likely to be wired in Manchester, it is interesting to speak of the arrangements rendered necessary by this system. The sketch shows clearly the arrangement of wires in the various rooms. It must be clearly understood that there is no difficulty in wiring buildings on the two-wire system, but in large premises a considerable saving can be effected by using five wires.

There is not another building in this country wired on the plan adopted in the Town Hall. To wire a building for 3,000 lights to successfully meet the exigencies of a 5-wire system meant a great deal of care in designing and arranging circuits, in order that a fair balance of current between the two outer wires should be maintained throughout the different departments and through the building. As the specification provided that no circuits should carry more than 25 ampères, and a large number of the circuits were to be controlled directly from the switchboard in the basement, a very large number of circuits was necessary. After much thought had been bestowed on the matter it was decided to use 36 circuits of 400 volts. This plan meant 200 wires being laid from the switchboard. It became of paramount importance to avoid crossing any of the wires or circuits, and this was done by arranging the leads to take three different courses.

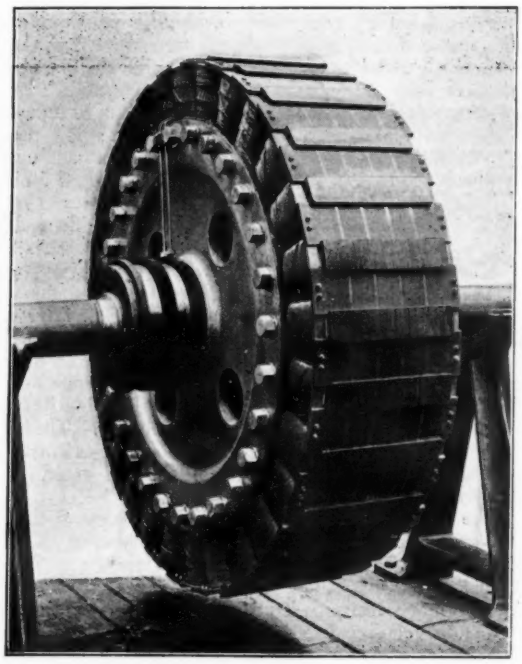
Plans and details of the proposed arrangement of leads were submitted to Dr. Hopkinson, who, as engineer, has supervised the whole of the undertaking, for his approval, and he expressed himself satisfied with the manner in which so difficult a problem had been solved.

The switchboard, which has been placed in the basement, is of exceedingly handsome design; the measurements being 12 feet long by 5 feet wide. The switches and all connections are insulated from the slate slabs, the slabs being fitted in very strong teak frames. The two outer wires are brought on to separate slabs. The diagrams show the arrangement of the lamps in the various rooms. In No. 1 room, for instance, is a 4-light electrolier, on which are four 100-volt lamps in series. These lamps are connected to the two outside mains, 1 and 5, which are at a difference of potential of 400 volts. The other two pendants are taken off the positive (No. 1), and the middle wire (No. 3), between which there is a difference of potential of 200 volts. Of course there is an obvious disadvantage in arranging one's lamps in series, but there seems no other way of meeting the special circumstances. In No. 2 room we have three lamps in series off No. 2 and 5 wires, and two in series off No. 3. Every branch from the mains, whether positive, negative, or intermediate, is protected by fusible cut-outs. The wiring of all circuits has been so arranged that when all the lamps are on there is no current passing through the three intermediate wires at the switchboard. The whole of this work has been carried out by Messrs. Fowler, Lancaster & Co.

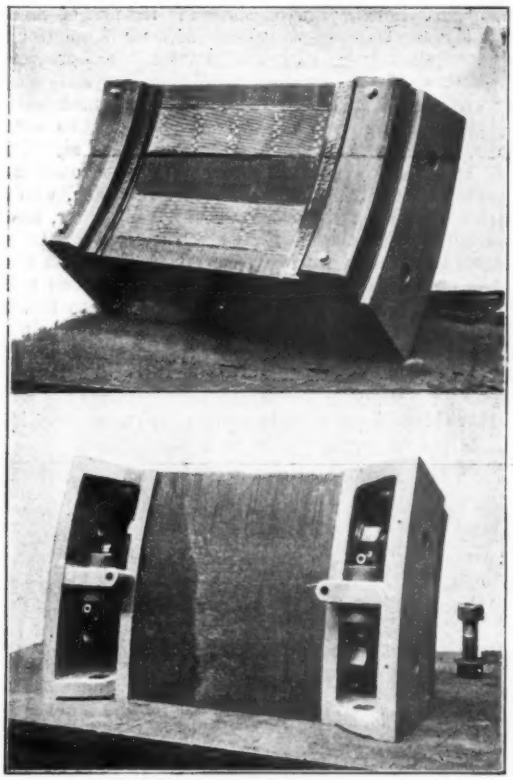
We ought to mention that Mr. C. H. Wordingham is the chief engineer.

THE BURTON CORPORATION WORKS.

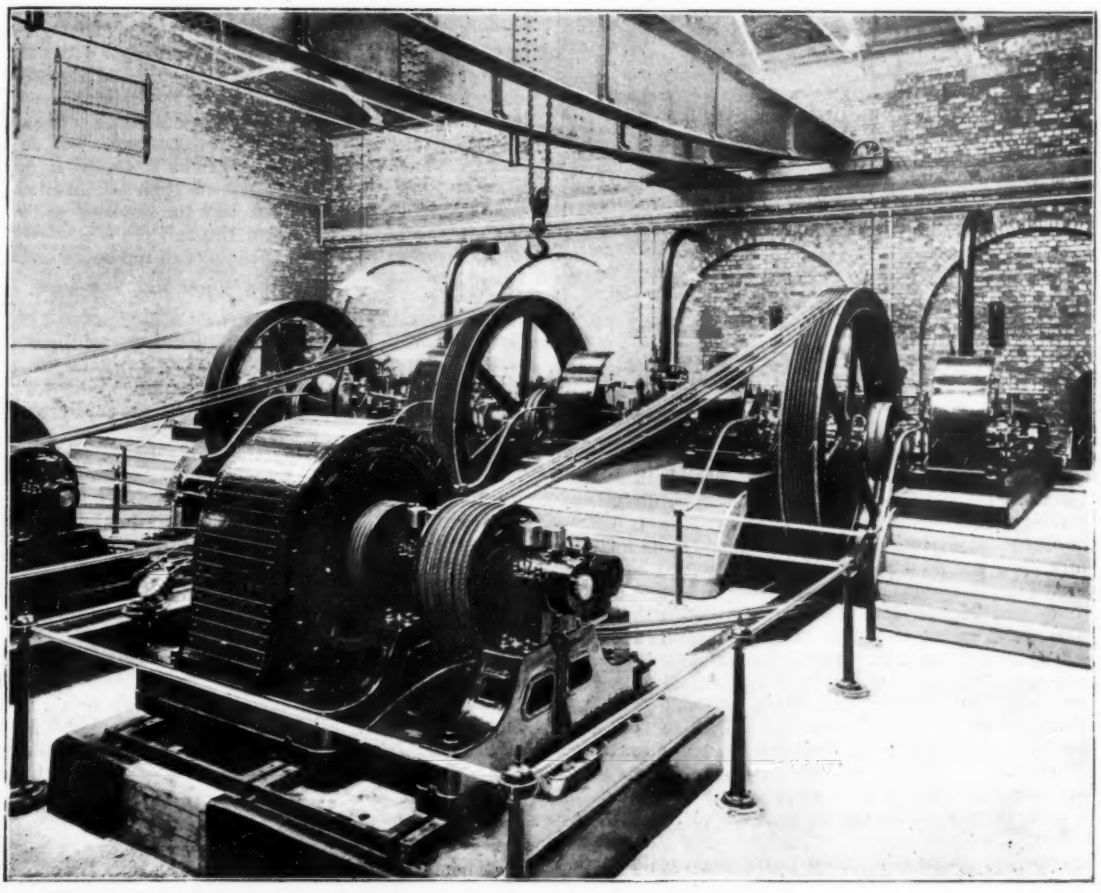
The Burton Station is the latest type of that which Messrs. Fowler and the Leeds and London Electrical Engineering Company have been mostly associated. It marks, however, an important departure in this system, for with these works we have the complete abandonment of the house transformer. No one know better than the supporters of this special system what this abolition of house transforming means. We must give the advocates of this method credit for the consistent manner in which they have tried and improved as far as possible the house transforming method, and it says a good deal that in spite of the inherent defects of the system, they have been able to show such economical results. Still it has been long felt that the method was fast becoming obsolete, and that a more efficient transforming means must



Revolving Field Magnet for Hall Machine



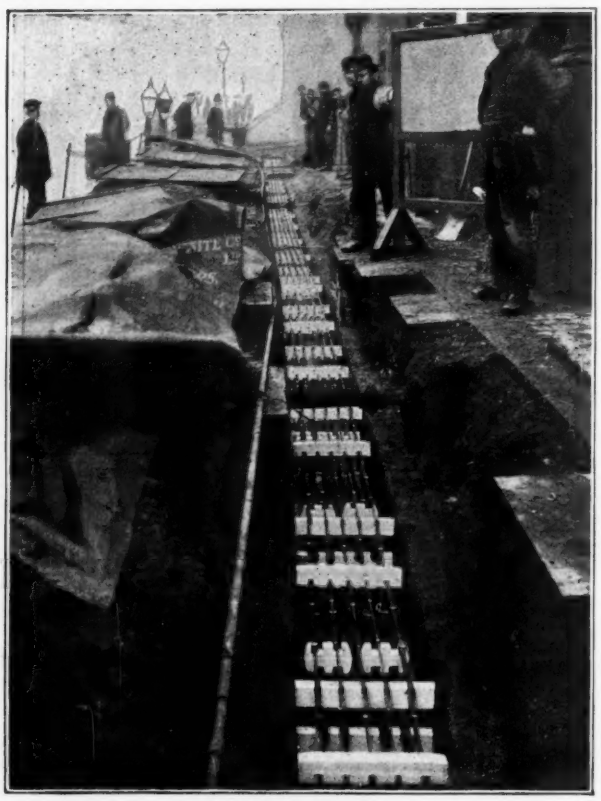
Section (front and back) of Hall Armature.



View of Burton Works.

be adopted, hence the Burton station is the first of its class to employ the transformer sub-station, and if only for this reason, we shall watch with special interest the progress of these works.

Apart, however, from the merely technical modifications which this station involves, there are one or two matters connected with its working which are novel and significant. In the first place we have the somewhat unique combination of a gas and electrical manager. Mr. Ramsden, who has been for some time the Corporation gas engineer, has in fact superintended the erection of the station, and he now combines the dual occupations of manager of the gas works, and the engineer of the electrical works. The two undertakings stand side by side, and it is satisfactory to find that this is not the only instance in which the two help and influence one another. The novel experiment is being tried of inducing the electric light station to utilise as far as possible for fuel, coke breeze, the refuse of the gas works. Whether this will prove to be a complete success remains to



The Manchester Mains.

be seen, thus far, we believe, the results are as satisfactory as one could expect, and we have reason to think that with due leavening the coke breeze may become a useful fuel, at any rate during the hours of light load.

The Corporation station then was practically and informally opened in the early part of last month. The contracts were, with the exception of buildings, given to Messrs. Fowler and Sons and Messrs. Hammond & Co., though the latter firm afterwards retired on Mr. Hammond's decision to devote himself entirely to consulting work.

The System.

Briefly, the system is an alternating high pressure of 2,000 volts with street transformers, feeding a low tension network at 100 volts.

As we have mentioned previously, the site of the station abuts on to the gas works, but there is ample room for extensions.

The building is divided into dynamo room, boiler house, switch room, and testing rooms. The engine room is 60 feet long by 63 feet wide, though by the temporary nature of one of the end walls, the Corporation are apparently expecting speedy extensions.

The Plant.

The plant consists at present of three 125 H.P. engines, driving by ropes three 66 kw. alternators. The engines are of the well known Fowler type, horizontal compound non-condensing. They run at 90 revolutions per minute, and are capable of giving a much greater output than the 125 H.P. which we have mentioned. Both high and low pressure cylinders have automatic cut-off gear controlled by the governor. The dimensions of the engines are as follows :—High pressure cylinder, 14 inches diameter; low pressure cylinder, 24 inches diameter, the stroke being 24 inches. The fly-wheels are 12 feet in diameter, and are grooved for seven 1¼ inch ropes.

The boiler house is 60 feet long by 45 feet wide, and in it are placed at present three Lancashire boilers, each 26 feet long, by 7 feet diameter, constructed for a working pressure of 100 lbs. per square inch, with ample spare space for further boilers as they may be required. The fittings and mountings on these boilers include Mr. Bryan Donkin's forced draught arrangements for burning the coke dust and rubbish from the gas works, coke screenings, coke and coal slack. Each boiler is fitted with the bars dipping in a water tank, and one fan provides the blast for all. Three feed-water heaters are also provided. By these the exhaust steam is utilised to raise the temperature of the feed-water, so as to economise fuel. No condensers are used.

Pipe connections.—A very simple arrangement of the pipes rendered necessary by so many auxiliary parts of the plant, including all the requisite pipes to and from the engines, the water heaters, pumps, tanks, &c., has been neatly worked in. An auxiliary steam pipe is provided for supplying the pumps and stoker engine, independently of the main steam pipe. The donkey pumps for feeding the boilers are of the duplex ram type, each of sufficient capacity to feed two boilers when working at their full power. The main steam pipes are connected up in the form of a ring, to which both boiler and engine branches are connected, thus providing two ways by which the engines can be supplied with steam, so guarding against the possibility of break-down of the running of the engines, should any portion of the steam range give way or be under repair. These pipes are provided with a suitable number of stop valves placed between each engine and boiler, and are carried on brackets fixed to the wall of the engine house. The branch pipes to the engines are of wrought-iron, with wrought-iron flanges. The exhaust pipes lead off from under the low-pressure cylinders, and a stop valve is provided to each engine exhaust to shut it off from the main exhaust pipe. Valves are arranged so that the whole or part of the exhaust steam can be turned through the heaters or direct into the atmosphere through the roof of the boiler house.

Switch Room.

The apparatus in the switch room is constructed under the Lowrie-Hall patents, and on the lines of that of the works at West Brompton, &c., and provides for the putting on and off of either of the circuits and dynamos, either circuit and any dynamo being interchangeable. A synchronising board is also provided here.

The trenches containing the cables lead into the switch room at the back of the switchboard, where ample space is provided in which the connections from cables to switches or cross connections on the switchboard can be easily and safely inspected; at the same time it is kept perfectly private except for the proper officials. At the back of the switchboard the connections are all suitably labelled, so that the attendant in charge has always before him a means of tracing the connections.

The switchboard is designed to deal with two circuits, and is complete with all the necessary instruments for showing current or pressure for switching exciters on or off and for regulating the voltage so as to preserve a constant potential at the lamp terminals of the consumer, in accordance with the special regulations on this head made by the Board of Trade.

In the

Test Room

are Thomson's standard voltmeter; Siemens's dynamometers; Wheatstone bridge; Thomson reflecting galvanometer, &c.

The Alternators.

The alternators, which are constructed under Hall's patents,

are of strong mechanical construction, suitable for continuous running, and capable of withstanding rough usage. The shafts are of mild steel, running in gun-metal, lined with white metal bearings of large diameter and ample length; oil throwers and waste oil chambers are provided at each end of the bearing from which the waste oil is led into tanks in the base plate of the alternator. The field magnets, of which we give an illustration, are the rotating part of the alternator, and consist of laminated horse-shoe stampings built up overlapping (alternately) so as to form a complete circle with polar projections; these are bolted solid together and secured to the shaft at the boss by means of keys and set screws. Magnets so constructed give the maximum efficiency for the energy expended in magnetising them owing to the quality of the iron, and, being laminated, are quite free from eddy currents which would cause energy to be dissipated in them if they were solid, due to the armature reaction. The armature being stationary lends itself for sectional construction, and as this is built up of laminated charcoal iron sheets with short polar projections, each section having its own armature coil securely attached, can readily be removed for inspection or repairs without interfering with any other part of the machine. The armature coil, two sections of which we illustrate, is insulated from the armature core, this is then again insulated from the frame of the machine, thus giving a double insulation between the conductor and frame or earth. The main terminals being mounted upon porcelain insulators and enclosed in the wood lagging, make it impossible for personal contact with the high-pressure conductors. The alternators are separately excited by small continuous current dynamos driven back by means of a pulley fixed on the alternator shaft. The low current density at which these machines are constructed will readily permit of their being considerably overloaded with safety during the short period of maximum demand.

Distribution.

The distribution of electricity is effected by means of stranded copper single cables, insulated with vulcanised India-rubber and laid in a specially designed system of pipes combined with service and junction boxes. Each junction box has a loose cover, held in position by a wrought-iron clamp. The culvert connection from the box to the consumer is made of wrought-iron piping. The surface boxes are in all cases placed at the corners of the roads, and in the case of a long straight run they are placed at distances of 80 to 100 yards apart. The surface boxes are made in two parts, the bottom part being permanent and the upper part with the cover being adjustable, so as to allow its surface to be raised or lowered as the road level may vary, the lid being filled in with wood, macadam, or pavement, according to the construction of the road.

From the surface boxes the cables can be drawn in or out as required. Where passing round corners the cable is placed on a revolving drum, which entirely prevents the possibility of abrasion. The jointing of branch cables for consumers' premises is done by cutting away part of the insulation of the main cable, which consists of India-rubber in the junction or surface boxes, and soldering the copper conductor to the conductor of the branch cable; the joint is then lapped over with rubber to the full thickness of the original insulation and vulcanised on the spot, and the cable well taped and mechanically protected. This makes the insulation of the joint practically equal to that of the cable itself.

The converters are of Lowrie-Hall pattern, and made by Messrs. John Fowler & Co. They are solidly built, and thoroughly well insulated in order to avoid any chance of "burning up," and are placed about 220 yards apart in cast-iron waterproof chambers with side wings or boxes cast upon them, so that the pipes conveying the high-pressure cables (2,000 volts) pass in on one side, and those containing the low-pressure cables (100 volts) on the other side; the cables themselves passing through the stuffing boxes into the water-tight chamber. The principle of the stuffing box is the compression of a substantial vulcanised India-rubber ring of the same quality as the cable itself.

In the interior of the box is placed a converter, together with high and low pressure fuses, earthing device, and high and low pressure switches: the latter are double-pole double-break and connected together by an insulated distance piece, so that both switches are turned off at the same moment, thus preventing any sparking whatever load may be switched off.

In order to take up any original moisture which may have been in the air and fittings in the box, a jar of caustic potash is placed to absorb this moisture, and once dry it remains so until any future date when the box is re-opened.

NOTES.

The Health of Prof. Helmholtz.—Telegrams from Berlin on Monday announced the serious illness of Prof. Von Helmholtz. An attack of paralysis seized him last Thursday, and his condition for some time caused anxiety. We are, however, very glad to learn from later despatches that the Professor is improving, and we sincerely hope he will continue to do so.

The Electrical Condition of the Air at High Altitudes.—It is probable that our knowledge of atmospheric electricity can be extended better by means of balloon ascensions than from observations from the tops of lofty buildings or from high points on the earth's surface, for at such points it is rarely or never possible to obtain conditions of uniformity. The study of the electrical conditions of the atmosphere by means of balloons would be really a praiseworthy outlet for aeronautic energy. Within recent years various measures of the potential of the air at different heights have been made during balloon ascensions. The theory which has been commonly held is that of Peltier, namely, that the earth has a negative charge, and is also surrounded by an electrostatic field; the equi-potential surfaces are approximately parallel to the earth's surface, and the positive charge increases with the height. The experiments of Weber, Elster, and others, appear to confirm this, but in a paper recently published in the *Annalen der Physik und Chemie*, by Börnstein, the results obtained by five observers acting independently of each other, demonstrated that the potential decreases with increasing height; it is possible, Börnstein thinks, that there may exist in the atmosphere "masses" of electricity of positive sign. Meanwhile there is the same need for more observations in this field of research, as in most others. If a large number of observations could be made from balloons at different heights, we could construct without any difficulty curves which would show at a glance the electrical conditions of the atmosphere.

Manufacturing Caustic Soda by Electrolysis.—It is possible that the various applications of electrolysis will eventually find their true place rather as adjuncts to other manufacturing processes than as substitutes for them. A method recently devised by T. Craney appears to be a move in this direction; he proposes to prepare caustic soda—which, as everyone knows, is one of the most useful chemicals, and of almost cosmopolitan application—from brine by the *aid* of electrolysis. The decomposition of the salt solution in the cells is not carried to its full limit, but only to the extent of producing a 1 per cent. or 2 per cent. solution of caustic soda. This solution is then drawn off and its place supplied by water of condensation from the evaporators which are used in obtaining the soda in the more concentrated form. The salt brine is maintained on the anode side at its initial degree of strength, so that there is a constant supplying of raw material on the one hand, and a continuous removal of soda on the other. The plant in this process consists of a series of electrolytic cells, a receiver for the dilute caustic soda solution removed from the cathodes, electric generators, steam engines, boilers which are fed with the weak soda solution, to be run off when about doubled in strength into evaporators or vacuum pans from which the concentrated solution is discharged into kettles, where it is solidified. The idea underlying these arrangements is greater economy, which is stated to be effected to a high degree if the plant is kept in continuous action. It is not clear, however, what becomes of the chlorine inevitably produced during the electrolytic decomposition of the brine.

The Electro-Chemical Company.—On February 23rd we briefly commented upon the prospectus of this company, with the effect of bringing forth a letter bearing upon the subject in our next issue from the pen of Mr. Wm. H. Massey. In an editorial note we promised this gentleman that we should watch with more than ordinary interest the future developments of the company, but so far our vigils have been in vain. We should be glad if he, or Mr. Swinburne, could tell us how the company is progressing.

The Great American Search Light.—Trials with the Sandy Hook great search light are said to have been exceedingly satisfactory from the point of view of enabling vessels to observe their position. It has, however, proved unsatisfactory in the way it was hoped it would be a great success—namely, in showing that a torpedo boat can easily enter the bay, even within the radius of its rays. Repeated experiments have been made with the lamp, even when fitted with a dispersing lens of excellent make; but over and over again the boat was able to escape the notice of those who were endeavouring to keep it in sight.

Electrical Regulations in France.—A commission of experts has been appointed to examine a Bill regulating the installation of electric leads for the transmission of light and of motive power. The object is to prevent interference with the working of telegraphs and telephones. The commissioners, says *La Lumière Electrique*, recommend that, except on public roads, electric conductors not destined for the transmission of signals or speech, may be installed without authorisation or declaration. Aerial leads cannot be established within a zone of 10 metres horizontally on each side of a telegraphic or telephonic line without previous understanding with the Administration of Posts and Telegraphs. This department must notify within the limit of three months from the date of the above declaration, any modifications which may be necessary. The Ministry, after consultation with the Committee of Electricity, determines any modifications required in conductors already existing within the specified zone, reserving rights already acquired. There will be constituted at the Ministries of Commerce and Industry, and of Posts and Telegraphs, a permanent electrical commission, composed one-half of professional representatives of the great electrical industries of France, or of industries making use of the applications of electricity. This commission will advise on all questions submitted to it by the Ministry. Every electric installation must be worked and maintained so as not to occasion by induction, derivation, or otherwise, any disturbance in telegraphic or telephonic transmissions on pre-existing lines.

A New Electrical Furnace.—Hitherto in the treatment of ores and other materials by means of electrical smelting, it has been thought desirable to feed these materials into the furnace in as finely-divided a condition as possible, consistent with commercial practicability. Consequently Mons. Girard's notion of passing the materials to be treated into the furnace in a solid state, in a continuous "rod" or cylinder, is almost revolutionary. Of course, this departure is recommended only when the material is itself a conductor of electricity; it is then fed through a hole placed longitudinally in the refractory sides of the furnace. Transverse or radial holes meet this longitudinal one, and permit the insertion of carbons between which and the travelling "rod" of ore the arc is formed which is to supply the heat required. The temperature can be regulated by adjusting the rate of travel of the "rod." In cases where the material to be treated is of a pulverulent character, it is caused to pass through the furnace in a hollow tube of carbon, which either carries the material with it, or is itself stationary and merely acts as a suitable conduit. Mons. Girard's latest improvements in electrical furnaces have been worked out in conjunction with Mons. Street. These involve arrangements for collecting the material, for causing the smelting to take place in an atmosphere of any gas at any pressure, and for enabling the whole of the material to be treated uniformly while either it or the arc is caused to rotate. In one arrangement a magnetic field is so employed that the arc will by the electric action automatically rotate without any relative movement of the parts of the furnace or apparatus.

Street Lighting in Aberdeen.—Joint Committees of the Town Council are going to consider the question of increasing the charge of the public lamps from 2¼d. to 3¼d.

Forfar and Electric Lighting.—The Northern Electric Supply Company intend applying for a provisional order. They are likely to be opposed by the Commissioners.

The Bolton Electricity Works.—The tender of Messrs. Siemens Bros. for supplying and laying the requisite electricity mains for extension in Knowsley Street has been accepted. The contractors for the stone and brickwork at the electricity station were to be informed that unless the work in their respective contracts be completed by August 1st and 18th respectively, the penalties for non-completion, as provided in their contracts, will be enforced. The work of substituting the central gas lamp on the Town Hall Square by an electric lamp of 2,000 candle-power was ordered to be carried out. The electrical engineer reported that applications for current were continuing to come in, and that 20 consumers had applied up to date for light to the extent of 2,000 8-C.P. lamps.

Fatal Operation.—An inquest held the other day details what, to us, appears a truly shocking incident which recently occurred in one of our London hospitals. It was an enquiry held by Dr. Wynn Westcott concerning the death of George Hurley, aged six weeks, the son of a cabinet-maker, of Brunswick Street, Hackney. The child had a nævus on the top of his head, and by the advice of a doctor was taken to the Children's Hospital, Goldsmith's Row, where the nævus was burnt out by electric cautery. Subsequently the little fellow became convulsed, and on Wednesday morning was seized with a fit. Death ensued before a doctor could be called. Dr. Simpson, of Hackney Road, said that death was due to inflammation of the brain, due to the electric cautery having burned too deep into the child's head. A verdict of "Accidental death" was returned. Speaking of the facts as they appear above, it is most lamentable that such accidents should occur. Accidents, of course, will happen, but electricity in the hands of most medical men is a dangerous and lethal power. They know next to nothing about its characteristics, and consequently often use it with a lamentable disregard of human life and suffering.

The City Inspectorship.—Ballots taken at last Tuesday's meeting of the City Authorities resulted in favour of Mr. Voysey, who gained 32 votes against 22 secured by Mr. Carver, and was accordingly appointed. The Commissioners made a commiseration grant of 10 guineas to each of the two unsuccessful candidates, Messrs. Gerhardi and Carver.

Mr. Voysey, who has secured the appointment, learned mechanical engineering at Barrow Steel Works, and was at Hanover Square School, under the late Mr. Lant Carpenter, and passed first in all the examinations. Later, he was with Messrs. Siemens Bros. & Co., under their chief electrician. He was next with Callender's Company, and for them put down the distributing systems in Liverpool and Birmingham, and also carried out other works in London and Denmark for the same company. Mr. Voysey is the inventor of a road breaker, which has already been described in the Electrical Review. He will commence his duties in the City very shortly.

The following letter appears in Wednesday's issue of the *City Press*:—

Sir,—I should esteem it a favour if you would ask the following questions in your next issue, as there appears to be some heart-burning about the recent appointment of a City inspector of electric lighting:—1st. Whether it is not a fact that the appointment of an electric inspector for the City of London was referred to Mr. Preece, and practically settled by him instead of by the Commissioners of Sewers? 2nd. Whether it is not a fact that in the recent competition for this post Mr. Preece, to whom the matter was referred, had not himself given testimonials in support of certain candidates? 3rd. Whether in such event Mr. Preece was a free arbitrator, and whether it was fair to the other candidates to refer the matter to a gentleman whose testimonials pledged him beforehand to a certain course of action. 4th. Whether the Commission of Sewers have not evaded their duty by referring the matter to anybody, instead of settling it themselves, and, further, whether such a course of action does not amount to a confession that they were unfit to make the appointment of such an official?—I am, &c., Electricity.

Broadstairs and St. Peter's and Electric Lighting.—The County of London and Brush Provincial Electric Lighting Company intends applying for a provisional order to supply these districts. The Local Board intend opposing the application.

Denbigh and Electric Lighting.—The Gas Company will not accept 3s. 8d. per 1,000 feet for the public gas lighting, and as the Town Council do not feel inclined to pay more, inquiries are being made regarding the best way to set to work to introduce electric lighting.

Appointment Deferred.—The Glasgow and South Western Railway have decided in the meantime not to appoint a mechanical and electrical engineer for St. Enoch Station, and, according to a Glasgow paper, those who had applied for the situation are wondering why. This is a new post on the railway, and a salary of £200 was offered.

Madras Electric Tramways.—A correspondent of a Madras paper states that the cables by which electric power will be transmitted to the cars of these tramways are to be placed in conduits under the lines. During the rainy season, that part of the tramway which is between the Head Office and the School of Arts will be often under water. The water in the conduits will be in free communication with that covering the roadway. "Is it not likely," asks the correspondent, "that the whole of the water will become highly charged with electricity? And if this happens, will it not be a source of inconvenience, if not serious danger, to those using that roadway while it is so submerged?"

The Photo-electric Action of Light.—The difficulties of working with ordinary polarised light in studying its photo-electric action disappear if the cathodes are formed of the alkaline metals, and advantage has recently been taken of this fact by Dr. J. Elster and H. Geitel. In the circuit of a voltaic battery of about 250 volts were placed a sensitive galvanometer, a commutator, and a sensitive cell of the liquid potassium-sodium alloy of the form described in *Wiedemann's Annalen*, Vol. xlii., p. 564, so inserted that the negative pole wire leads to the surface of the alkali metal. The cell was coated with opaque varnish, with the exception of a small circle 15 mm. in diameter, which was turned towards the source of light. The rays entering this aperture centrally and parallel, struck the centre of the metal surface under an angle of 65°, and between the source of light and the sensitive cell a lens was introduced for making the light parallel, as well as a polarising arrangement. It was found with this apparatus that if the polarising device is turned, while at the same time the strength of the current is measured in the galvanometer, two maxima and two minima are seen in the course of a single rotation. The ratio of maxima to minima is about 10 : 1. Other observations were made, which we can scarcely refer to here; but it will be remembered that, according to the results of Tronton, Klemencic and Righi, it must be taken for granted that in Hertz's rays of electrical force, the plane of polarisation is at right angles to the direction of the electrical displacement. So if the motion in the light rays is regarded as analogous, the result of the experiments made by Elster and Geitel would be thus expressed:—The luminous electrical current attains its maximum when the electrical displacement in the luminous ray takes place in the plane of incidence, its minimum when they are at right angles thereto. In the former case the electrical vibrations contain a component normal to the cathode, but not in the second. We might be tempted to seek in these changes of potential normal to the cathode, and induced by the electrical rays, the force which impels the negative electricity to leave the cathode. Whether this suggestion is correct can perhaps be ascertained by further experiments on the dependence of the luminous electrical action on the angle of incidence of the polarised light, and their connection with the quantities of light reflected from and retained by the cathode. Further details may be found in a paper communicated by Elster and Geitel to the *Phil. Mag.*, July issue.

A Voluminous Patent.—A patent (No. 11,294—1893), of R. Pippette, relating to "Improvements in Automatic Electric Exchanges," just published, contains 336 numbered paragraphs and 219 separate figures.

Farewell Dinner to Mr. Kapp.—A farewell dinner will be given by prominent electrical men to Mr. Kapp, at the Whitehall Club on Monday night, to mark an appreciation of his services to electrical engineering.

A Correction.—The Hughes Type Printer.—We have been requested to correct a statement made in our issue of June 22nd, page 742, with reference to Willmot's air motor for driving the Hughes type printing telegraph. It is stated: "It replaces also the beautiful mechanism which formerly regulated the speed." This is incorrect, as the regulating spring used in the instrument is still retained.

NEW COMPANIES REGISTERED.

Economic Electric Specialty Company, Limited (41,561).—This company was registered on the 11th inst. with a capital of £50,000, in £1 shares, to carry on the manufacture and sale of electric, telegraphic, surgical, and scientific machines and instruments, and to supply electrical engineering and other goods and apparatus connected with the production of light, heat, sound, and power, or any other effects by electricity. The subscribers (with one share each) are:—J. E. Hay, Lansdowne, Neasden, N.W., stationer; C. Hoppe, 14, Southampton Street, W.C., gentleman; A. H. F. Young, 4, Buckleigh Road, Streatham, nautical surveyor; S. H. Nugent, Alwyne, Orleans Road, Hornsey Rise, N., accountant; A. T. Way, 3, Mount Pleasant, Barnsbury Square, N., accountant; J. Jackson, 132, Stanhope Street, N.W., merchant; W. Lee, 19, St. John's Road, S.W., jeweller. The number of directors is not to be less than three nor more than seven. The Ries Electric Specialty Company is entitled to nominate a director, who is to hold office so long as the company just named continue to hold 5,000 shares. The remuneration of the board is to be determined in general meeting. Registered office, Connaught Mansions, 34, Victoria Street, S.W.

Jones Bros. & Co., Birmingham, Limited (41,562).—This company was registered on the 11th inst., with a capital of £2,000, in £1 shares (1,000 preference and 1,000 ordinary), to carry on the business of manufacturers of brass hinges, manufacturers of electrical appliances, merchants and dealers in all kinds of machinery, metallurgists, and electrical engineers. The subscribers (with one share each) are: G. W. Verrin, Meriden House, Trinity Road, Handsworth, gentleman; S. C. Beel, Henshaw Road, Small Heath, gentleman; W. H. Taylor, Wyehwood, Rotton Park Road, Edgbaston, clerk; T. W. W. Perry, 69, St. Peter's Road, Handsworth, Birmingham, brassfounder; J. B. B. Holmes, Wyndclyffe, School Road, Moseley, architect; W. A. Perry, 69, St. Peter's Road, Birmingham, engineer; J. Cotterill, 84, Smith Street, Birmingham, warehouseman. There are never to be less than three, nor more than seven directors. Qualification, 50 shares. Registered by Barlow & James, 165, Fenchurch Street.

E. & E. Taylor, Limited (41,585).—This company was registered on the 14th inst. with a capital of £5,000, in £10 shares, to purchase and carry on, among other things, the businesses of electrical engineers and general manufacturers, now carried on by Edmund Taylor, under the style of E. & E. Taylor, at Moorgate Street, E.C., and at Brady Street Ironworks, E. The first subscribers are: Edmund Taylor, Sarah Taylor, Florence Taylor, Walter Hildesheim, Cäcilie Hildesheim, Evelyn Hildesheim, and C. F. Cheston. The first directors are Messrs. Edmund Taylor and W. Hildesheim; qualification, £750. Registered office, Tower Chambers, Finsbury Pavement, E.C.

Spanish Telephone Company, Limited (41,589).—This company was registered on the 16th inst., with a capital of £16,000, in £10 shares, to buy or otherwise acquire from A. Rüffer & Sons, all the share capital, ordinary and preferred, now issued of and in the Compania Peninsular de Teléfonos, for the sum of £32,000; to negotiate loans; and to carry on telephone and telegraph undertakings. The subscribers are:—E. Rüffer, 39, Lombard Street, E.C., merchant, 500 shares; H. Rüffer, 39, Lombard Street, E.C., merchant, 500 shares; H. E. Walton, Enfield, banker's clerk, 1 share; W. H. Stevens, Stoke Newington, N., banker's clerk, 1 share; A. P. Garnett, 11, Stockwell Park Road, S.W., banker's clerk, one share; C. H. Garnett, 77, Thornlaw Road, S.E., banker's clerk, one share; F. W. Rosy, 8, Grosvenor Street, S.E., banker's clerk, one share. The first directors are Messrs. E. Rüffer, H. Rüffer, and F. R. J. Radcliffe; qualification, £500. Registered office, 39, Lombard Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Syndicate of Electrical Engineers, Limited (30,531).—This company's annual return shows that out of a nominal capital of £10,000, in 1,900 ordinary and 100 founders' shares, all of £5 each, 1,007 ordinary and the whole of the founders' shares have been taken up. A call of £4 per share has been made on the ordinary shares, and the founders' shares have been agreed to be considered as paid. The total sum received in response to calls equals £4,003 10s., £24 10s. being still outstanding.

River Plate Electricity Company, Limited (28,213).—The yearly return of this company, made up to May 31st last, and filed quite recently, shows that out of a nominal capital of £500,000 in 49,900 £10 ordinary, and 1,000 £1 founders' shares, 13,557 ordinary and 892 founders' shares have been taken up. The total sum received in response to calls reaches £110,892, and £1,570 is outstanding. The full amount has been agreed to be considered as paid on 2,400 ordinary shares.

Saxby & Farmer, Limited (38,786).—The first yearly return of this company was filed a few days ago. It appears that out of a nominal capital of £25,000, in £10 shares, 2,021 shares have been taken up. The full amount has been called and paid on 221 shares, while the remaining shares have been issued as fully paid.

BUSINESS NOTICES, &c.

The City Commissioners and the Telephone Tubes.—For a long time past the City of London Electric Lighting Company have been wearily waiting for the City Commissioners of Sewers to sanction the use of the telephone tubes laid when they were putting down their mains in the city thoroughfares. The dilatory attitude taken up by the Commissioners in regard to the matter has been far from encouraging to the company. The matter, however, came up in resolution form last Tuesday, and after a very lengthy discussion, in which the company was accused of this, that, and the other, a vote was taken which resulted in a majority in favour of the company, though that majority was not large enough to allow the course proposed to be pursued. Mr. Gordon moved the following resolution: "That the resolution of this Court, of July 25th, 1893, agreeing to a recommendation of the Streets Committee, that the Commissioners only consent to the use for telephonic purposes of certain tubes laid by the City of London Electric Lighting Company, on a guarantee being given that telephones with double wires and all the latest improvements will be supplied to the citizens at a cost not exceeding £8 per annum, be rescinded; and that an offer of the said company to pay the Commissioners '10 per cent. of any annual rental, so long as such may be received for the use of any tubes for telephonic purposes, up to the sum of £10,000 per annum, and 20 per cent. on any rental in excess of £10,000,' be accepted, provided the minimum amount to be received by the Commissioners be £1,000 per annum, subject to a proper agreement being entered into with the company, without prejudice in any way to the rights and privileges of the Commissioners under the contracts and provisional orders." Mr. Gordon said, in bringing the motion forward, he wished to test the feeling of the Court, as the members of the Streets Committee were pretty evenly divided. There was no doubt in his own mind that the tubes were laid down without applying for permission in a proper manner. They were laid down surreptitiously, and the company should be punished accordingly. In order to carry out that intention the Court adopted a resolution on July 25th last asking the company to reduce the cost of telephony. But he had since realised that the Court had no *locus standi* to do that. There was no doubt that the Court was wrong as the proposed concession affected only 3,000 subscribers or users of telephones, which were a luxury. But by the second part of his motion on a sliding scale the whole community would be affected. And it was much better as a matter of principle that that should be so. If the Court persisted in its present action it would stultify itself. A contract had been entered into by the Electric Lighting Company and the Telephone Company, whereby the latter agreed to pay the former 10 per cent. on the cost of the tubes, the cost being estimated at £100,000 a year. That represented a minimum rent of £1,000 a year. The assessment of them would not be less than £2,500, making £3,500 per annum, which could be used in relieving the rates. He had reason to believe that within two years the rent would be increased to double, or about £20,000 a year. According to that offer, the Court could claim 20 per cent. on the second £10,000. In all, the sum of £8,000 would be available for reducing the rates. Mr. Gordon concluded by declaring that the time had arrived when the Commission should act in a businesslike way, and make some arrangement with the company, and that the tubes should be used for the benefit of the ratepayers generally.—Mr. Sayer, in seconding the resolution, said he wished to disagree with Mr. Gordon in his assertion that the electric lighting company had laid the tubes in a surreptitious manner. He was the then chairman of the Streets Committee, and they thought it best that the tubes should be laid in the interests of the citizens. It was true the committee had never given its consent, but he had thought all along that the laying of the telephone tubes in the same trenches with the electric lighting tubes would be for the benefit of those carrying on business in the City. The tubes were accordingly laid and the company received the consent of the Court afterwards, and he certainly thought the Commission would receive some concession from the company in consequence. Those tubes were now rotting, and under the present state of things the Commission was losing a large income. He hoped, therefore, that no further delay in securing that would be permitted.—Mr. Morton challenged the remarks made by Mr. Sayer to the effect that the tubes in question had been laid down by the consent of the Commission and the whole thing he said originated in the imagination of Mr. Sayer. It was no good for members to come to the Court with such cock-and-bull stories, for it was well known that the Commission refused to give its consent to the laying of the tubes. The silence of the Court on the question could only mean that its consent was withheld. The fact was the directors and the chairman of the company had been about the members of the Court, but he did not know how it was the latter had changed their minds. It had not affected his mind, for he remained of the same opinion. The committee had, moreover, no right to negotiate with the company, and in doing so it had gone out of its way. They had also had agents coming round among them, and he objected to that sort of thing. The proposal of Mr. Gordon simply meant that in order to make a little money the citizens and traders should be sold for about £3,000 a year.—Mr. Pannell said the proposition before the Court was that all classes of the citizens should share in any advantages that were likely to accrue under the proposed arrangement, and he was all the more surprised to find Mr. Morton, who ably represented the majority and the masses refusing to consent to the rescinding of the former resolution, by which only a comparatively few persons would benefit.—Mr. Deputy Scott observed that he was the chairman of the Commission at the time the question of the tubes was before the Court. He had no hesitation in saying that the various sections were shown, and it was stated at the time that the tubes which were to be placed therein were for telephonic purposes. It was also a matter of fact that the company might have gone to Parliament had it chosen for powers to reopen the streets again for the purpose of laying them—an eventuality, he submitted, which would have been intolerable to the citizens. The tubes were down, and, in his opinion, the Commission had no right to act like dogs in the manger and prevent the use of them, or the citizens gaining any benefit from their use. Such questions as the present were bound to arise in new undertakings, and he, for one, would support the resolution, in order that the citizens would benefit by what had taken place. Mr. Barham hoped that the Court would not rescind the resolution it had adopted twelve months ago. The electric lighting company had stolen a march upon the Commission, and, so far as he was able, he would never permit it to reap the advantage; but, on the contrary, would do all he could to force it to make concessions to the citizens. The people of London were, he said, as much entitled to secure cheap telephones as those living in Liverpool or Manchester, and yet it was proposed that the Commission should sell its birthright for a mess of pottage. So far from attempting to serve the interests of the citizens, the company had served its own purposes, and he hoped the Court would adhere to the course it had adopted; that the motion by Mr. Gordon would be rejected, and that the company would be made to feel that the offer it had submitted was an insult to the Commission. Several other commissioners having addressed the meeting the question was put to vote in two sections, and on a show of hands 22 voted for the first section and 18 against it. A division was claimed, with the result that 25 voted for, and 19 against. As a two-thirds majority was necessary, the section was declared to be lost.

Windsor Electric Lighting.—In their report the Electric Lighting Committee include the following paragraph: "Your committee considering that it was of great importance that the adjoining towns of Windsor and Eton should act in unison together, and being also unanimously of opinion that the supply of electricity can be carried into effect more economically and with greater certainty of financial success, by the inclusion of Eton and Eton College in the scheme, have put themselves into communication with the Eton Local Board, and have met a committee appointed by the Board in conference when the subject was fully discussed, and your committee have since received from the Eton Local Board the following resolution, viz.: 'This Board is willing to acquiesce in allowing Windsor to obtain a provisional order for lighting Eton with electricity, supposing satisfactory terms can be agreed upon.' Your committee recommend that the Town Council apply to the Board of Trade to revoke the Windsor Electric Lighting Order of 1890, which your committee are advised is the first step necessary to be taken. Your committee also recommend the Town Council to apply to the Board of Trade for a provisional order to supply electric light and power for public and private purposes within the borough, and also within the district of the Eton Local Board. Your committee ask the Council to grant to them authority to employ an electrical engineer to advise and report upon the subject." The Town Council adopted the report.

Electric Light at St. Pancras.—The Finance Committee of the London County Council last Tuesday reported that they had considered the application from the Vestry of St. Pancras for a further loan of £14,600 for 42 years on the annuity system for electric lighting purposes. They recommended "(*a*) That the resolution of the Council of February 13th, 1894, agreeing to advance to the Vestry of St. Pancras the sum of £29,700 for works for electric lighting purposes, be not further acted upon. (*b*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents, and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of St. Pancras for a loan of £14,600 towards defraying the cost of electric lighting works in the parish be granted to the extent of £14,300, on condition that the loan be taken up at once, interest being charged thereon at the rate of £3 10s. per cent. per annum, calculated quarterly, and with the principal being repaid by such equal half-yearly payments of principal and interest combined as will repay the amount borrowed within a period of 42 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund." The recommendation was adopted.

Electrical Wayzgeese.—(Reviewer of Reviewers please note). The employés of the Brighton Corporation Electricity Works had their annual outing on Saturday last.

The London staff of the General Electric Company, on a similar errand bent, visited Epping Forest last Saturday. The whole of the company, numbering 125, drove from Walthamstow to the King's Oak Hotel where athletic sports were held, after which a first-rate dinner was served and eaten. After tea the return journey was made through some charming bits of forest scenery to Hoe Street Station, whence the whole of the company returned to town.

Church Lighting.—It is proposed to light West Hackney Church by electricity.

The lighting of St. James's Church, Taunton, by incandescent lamps has been successfully done. Arc lamps have been used in this church for 7½ years, but these have been replaced by clusters of 32 C.P. incandescent lamps. The whole of the arrangements have been planned and carried out by Mr. F. M. Newton, of the Newton Electrical Works, Rowbarton.

Electrical Engineering as a Profession.—Messrs. Southam & Co., publishers, of Paternoster Row, state that as they are now preparing the second and revised edition of "Electrical Engineering as a Profession, How to Enter It," they would be glad if any of our readers who may have a vacancy for a pupil would communicate with them, stating the premium required, wages given (if any), the hours of attendance, together with a few remarks concerning the course of instruction.

College Lighting.—Messrs. Baker Hill & Co., of Oxford, are carrying out the lighting of Worcester College where 400 lights are being installed in the undergraduates' and fellows' rooms, kitchens, staircases, library, hall, and chapel. Mr. J. H. McLean, M.I.E.E., is the consulting engineer. They are also installing 350 lights in Wadham College, 150 in Trinity College, and 50 in Exeter College. In the two last colleges, the work which the firm did last year is being extended.

Electric Light Ladders.—The Lancashire and Yorkshire Railway Company has just ordered one of Heathman's patent telescopic ladder towers for use by the electric light attendants at the Exchange Station, Liverpool, while Messrs. Heathman have also received instructions to build two more for the Great Eastern Railway stations, and a portable ladder carriage for the Bath Electric Light Company.

Gas, Water, and Electric Lighting Companies' Directory.—This annual publication contains a specially written summary of the leading events of the year in the gas, water, and electric lighting industries, and a list of companies and officials, with other useful matter in the way of statistics and comparisons. It is issued by Hazell, Watson & Viney, London.

Lighting at Leicester.—The Corporation expect to be able to supply light by the end of October.

Briscoe & Shaw.—This firm have received the following contracts:—Lighting throughout Messrs. Higson Brothers' weaving shed, Blackburn; also Messrs. Kenyon Brothers' weaving shed at Blackburn. Messrs. Rosling & Matthews supplied the dynamos. Messrs. Briscoe & Shaw also have in hand the wiring of Blackburn District Club and of the Blackburn Supply Stores, Market Place.

Colliery Lighting.—The Clay Cross Colliery Company have placed an order with the Acme and Immisch Electric Works, Limited, of Chalk Farm, for a complete plant consisting of engine and dynamo, &c., for 200 16-C.P. lamps, to light their surface works and pit bottom. We understand the work is well in hand and approaching completion.

Theatre Lighting.—Messrs. Baker Hill & Co. have the order to light the Sheldonian Theatre, Oxford, and part of the museum for the meeting of the British Association in August. They have also in hand the lighting of several shops and private houses.

New Electrical Manufacturers.—The Sandrycroft Foundry Company have added an electrical department to their works for the manufacture of electrical machinery. The new department is to be under the charge of Prof. N. S. Keith, M.Inst.E.E.

"How's That?"—A country paper states that during a cricket match in Ireland (of course), a flash of lightning struck a wicket and splintered the stumps to matchwood. Such a proceeding almost rivals Richardson's best performance.

Devonport and the Gas Contract.—In view of the rapid extensions of electric lighting the Council have made their new contract with the gas company terminable at periods of three, five, and seven years by six months' notice.

The St. James's Company in Lambeth.—The St. James's and Pall Mall Company have advised the Lambeth Vestry that they intend to apply for a Provisional Order to supply electricity in certain parts of Lambeth.

Lighting Birmingham by Welsh Water.—A correspondent in the *Birmingham Post* suggests that the Welsh water supply could give power enough to light Birmingham and adjacent towns with the electric light.

Lighting of the Scottish Provident Institution in Ireland.—The new premises of this Institution in Dublin have been wired by Messrs. Porte Sykes & Co., of Dawson Street, Dublin.

Hammersmith Vestry Behind the Age.—The Electric Light Committee advise the Vestry to apply to the Board of Trade for an extension of time for laying the compulsory mains.

Great Crosby Lighting.—Few places are now outside the pale of electric lighting. The Holloway Electric Lighting Company are going to apply for powers to light Great Crosby.

Lighting at Abroath.—The Northern Electric Light Company are anxious to light Abroath, and with that end in view they will apply for a provisional order.

Lighting of Dalston by the Vestry.—The Vestry have decided to apply to the County Council for sanction to borrow £12,300 for electric lighting purposes.

Lighting at Leith Docks.—The estimate of the Brush Company for the supply of electrical plant and fittings for a portion of the docks has been accepted.

New Branch.—The Telegraph Manufacturing Company, Limited, of Helsby, have opened an office at No. 2, Parsonage, Manchester.

A Big Load.—The load of the Blackpool Electricity Works reached high water mark last Saturday when a record output was made.

Electricity on the Midland.—The Midland Railway Company are extending the electric light on their Leicester premises.

Street Lighting Experiments at Coatbridge.—The Town Council are going to try the effect of arc lamps for the streets.

The Lighting of Tuam.—The Irish Electrical Supply Company, Limited, intend to apply for powers to light Tuam.

CITY NOTES.

Electrical Power Storage Company, Limited.

THE directors' report states that the net profit for the year is £4,936 4s. 11d., which, with a balance of £158 19s. 5d. from last year's accounts, amounts to £5,095 4s. 4d., out of which the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb £4,101 10s. 2d., leaving £993 14s. 2d. to be carried forward. Provision has been made for the effective maintenance of buildings, plant, tools, &c., at a cost of £2,297 6s. 2d. The sum of £3,323 1s. 4d., the proceeds of sale of the company's shares in the Société Française, together with a further sum of £4,000 out of the profit on the year's working, and £1,500 written off patents in 1892-3, have been applied to the formation of a reserve fund for diminution in value of assets, as shown in the balance-sheet. The directors are pleased to be able to report the continued

success of the company's operations, and that there has been during the year a substantial increase of orders and of the uses to which batteries are being applied. The reduction in the selling price of the company's manufactures has operated towards increasing the number of users, and so extending the goodwill of the business. Constant attention has been devoted to improving the conditions under which E.P.S. batteries are manufactured, and the directors are sanguine of further success in this direction. The development of electric traction has received the unremitting attention of the manager. The company and its licensees have been successful in patent litigation abroad.

At the meeting held yesterday, Mr. Courtenay said that they recommended a dividend of 5 per cent., and carry forward a substantial balance to next year. The reserve fund stood at £9,315 7s. 1d., and it was satisfactory that they had been able to bring it up to that amount. The volume of business had very considerably increased, and the actual cash turn-over is larger than it was last year, although the reduction in the list prices of 20 per cent. had been in operation during the whole of the year under review. There was an increasing competition, but the E.P.S. batteries had held their own thoroughly well. The policy adopted by the directors and manager had been to continually improve the quality of the company's manufactures, and the results show the E.P.S. batteries to be the most appreciated and reliable in the market, and that the sound commercial policy is to improve them in various details (though no startling new departure has been made), rather than to spend money and time in spasmodic efforts to obtain entirely new types or designs. One of the most important features to be noted was that the life of E.P.S. secondary batteries is steadily lengthening, so that in fact a sum equal to 5 per cent. per annum on the cost price is now amply sufficient for the maintenance in perfect working order of the batteries used under ordinary conditions. Those who remember the pessimistic views expressed only a few years ago as to what would be the safe annual percentage to cover maintenance, will feel gratified at the practical illustration given by this company of the correctness of the views of its representatives. He remembered being told that it would never pay any company to guarantee the maintenance of storage batteries at twice the figure now commonly adopted, but their manager has always contended that it could safely be done at about the present prices. Numerous fresh uses continue to be found for the employment of secondary batteries, and the number of customers was larger than ever. They were not able yet to point to a decided success in the application of E.P.S. batteries to traction, but they *must* make a success of this important branch of the industry, and he believed that Mr. King would not fail in his efforts to this end, though the difficulties in the way of its development have been great. As stated in the report, unremitting attention had been given to the improvement of the batteries for traction purposes and to appliances in connection therewith, and he hoped that vehicles belonging to their friends the Pioneer Electric Carriage Company, Limited, fitted with the latest type of traction battery would be publicly working shortly. During the year various improvements had been made in the plant, and in the arrangement of the works at Millwall with the object of cheapening production, but he did not consider it advisable to indicate more fully the direction these improvements had taken. The works had been to a certain extent remodelled, and several suggestions made by the Board of Trade for the greater comfort and health of their workmen had been carried out. The company's Continental patents had been admirably protected by the Hagen Company and their legal and technical advisers, who had been most successful in upholding the patent rights.

Sir Daniel Cooper seconded the adoption of the report and accounts, which was carried.

The retiring director and the auditors were re-elected, which concluded the business of the meeting.

Eastern Telegraph Company, Limited.

The forty-fourth half-yearly ordinary general meeting of this company was held on Thursday last week at Winchester House.

Sir John Pender, M.P., who presided, in moving the adoption of the report, stated that the gross revenue for the half-year amounted to £389,314, as against £372,853, or an increase of £16,461. The increase in the gross revenue was principally due to the receipt of £29,500 from the investment in the shares of the Eastern and South African Telegraph Company, against £17,700 in the corresponding period, due to the bonus being paid at the end of the year instead of half-yearly as formerly. The total ordinary expenses for the year had decreased by £280. They recommended the usual final dividend of 1½ per cent., and a bonus of 1½ per cent., making a total distribution of 6½ per cent. for the year. They would carry £110,000 to the reserve fund, against £88,000 in the corresponding period; and when the revival took place there would be very good times indeed for their submarine telegraph system.

The motion having been carried, the final dividend and bonus recommended were declared.

Elmore's French Copper Depositing Company, Limited.

Yesterday a meeting of this company was held at Winchester House to hear a statement and recommendation of the liquidator, Mr. Duncan, who said that the special objects of the meeting was to appoint a board for the resuscitation of the company. It would be remembered that at the meetings held at the end of December a scheme of distribution was approved, but the Courts rising shortly afterwards, the order was not received until February. The scheme provided for the distribution among the debenture holders of certain interests in the French company, and handing over to this company the balance of assets. The assets to be handed over were the founders' shares, which represented the reversion of the income of the French Company and the Bellegarde land. They had now to constitute someone to receive the assets from him (the liquidator). As they knew, the company was not defunct, for they had power to go to the Court and ask that all the proceedings for winding-up should be stayed. Before that, they had to settle with all the creditors; but the scheme, to some extent, bound them. The list of creditors, he hoped, would be complete next month. The question was who would they appoint as a board. He would indicate that one of the committee might be selected, and, perhaps, one of the old administration, and, considering the peculiar state of the company, it would be safe to have a creditor on the board. Speaking of the French Company, they had got into thorough working order, and by the end of this month, or at the beginning of next month, they would be working on an extended scale. They had been face to face with very serious difficulties on account of competition, but some arrangement had been made with the competitors.

Mr. F. L. Rawson addressed the meeting in support of certain names as directors, and proposed Mr. Duncan, Mr. Strettal, and Mr. Shurmer. This was seconded and adopted.

The National Telephone Company, Limited.

The report of the directors for the 14 months ending June 30th, 1894, states that it will be in the recollection of the proprietors that at an extraordinary general meeting, held on January 18th last, it was resolved: "That in future two ordinary general meetings be held in each year, and that the directors be requested to take the necessary steps to have the articles of association of the company altered accordingly." It was also determined that these meetings should be so arranged as to fit in with the calendar year, in order that the accounts up to June 30th and December 31st in each year could hereafter be submitted to the respective meetings. To carry out this alteration it has been necessary to present the accounts accompanying this report made up to June 30th, 1894, embracing, therefore, 14 months, in comparison with the last accounts for 12 months to April 30th, 1893. The income accrued in respect of the business of the 14 months amounts to £800,544 15s. 8d., as compared with £583,590 2s. 11d. for the preceding 12 months, being an increase of £216,954 12s. 9d. The rentals carried forward for the unexpired terms of running contracts amount to £345,358 18s. 5d., as compared with £285,020 7s. 8d. for the preceding year, or an increase of £60,338 10s. 9d. The working expenses and other charges for the 14 months (excluding debenture and other interest) amount to £410,115 3s. 10d., as compared with £311,644 10s. 2d. for the preceding 12 months, being an increase of £98,470 13s. 8d. The net result for the 14 months, after deducting the Post Office royalties amounting to £73,945 15s. 3d., is a profit balance of £316,483 16s. 7d., as compared with a balance of £217,725 2s. 11d. for the preceding 12 months, being an increase of £98,758 13s. 8d. A reference to the abstract of accounts appended to the report will show the aggregate receipts, expenditure, and net revenue made up for the 12 months ending April 30th, 1894, and for the additional months of May and June. The accounts for May have been audited, and estimates for June on a safe basis have been introduced. During the year the purchase of the Irish Telephone Company and some smaller undertakings has been completed, and the income arising from them has been brought into the accounts for the first time. Out of the available balance of £262,311 12s. 5d. shown by the net revenue account (No. 3) an interim dividend at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares has already been paid. The board will recommend a further payment at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares, making the dividend for the 14 months at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares. The board also propose to transfer £63,429 1s. to the reserve fund, so as to bring it up to £225,000, and to carry forward the balance of £1,765 3s. 11d. The negotiations with the Post Office in relation to the acquisition of the trunk lines of the company have revealed many unforeseen difficulties of detail. These have occupied much time to solve in a manner satisfactory to both parties, but happily are now practically overcome, and the agreement itself is in such form as will enable the Postmaster-General to lay it on the table of the House of Commons, in accordance with his promise to that effect. The condition of the money market had for some time been such as to force upon the attention of the board the question whether in the interest of the shareholders they must not avail themselves of the option reserved to the company to redeem the £1,000,000 of 4½ per cent. debenture stock already issued. They came to the conclusion that they should do so, provided the terms upon which the success of a new issue could be practically secured would afford sufficient inducement. They ascertained that this could be effected by conversion into a 3½ per cent. debenture stock, and accordingly the arrangement has been carried out upon the conditions of the prospectus advertised in the newspapers, and posted to the proprietors. At the general meeting four directors retire, and, being eligible, offer themselves for re-election, viz., Mr. George Franklin, Mr. William Cuthbert Quilter, M.P., Mr. William Alexander Smith, and Mr. Alderman Joseph Thompson. The auditors, Messrs. Welton, Jones & Co., also retire, and are eligible for re-election.

THE FOLLOWING IS AN ABSTRACT OF ACCOUNTS.

Year ending April 10th.	Income accrued in respect of the business of the year.	Working expenses and other charges, excluding debenture and other interest.	Balance.	Less Post Office royalties.	Net result for the year.	Amount from previous year.	Debenture and other interest.	Preference and ordinary dividend.	Carried to reserve fund.	Carried forward.	Rentals carried forward for unexpired terms.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1890	380,075 3 3	157,590 1 3	222,485 2 0	30,493 13 11	191,991 8 1	2,765 7 9	11,380 16 3	132,262 10 0	40,000 0 0	11,113 9 7	200,918 1 3
1891	431,112 11 11	199,483 15 8	231,628 16 3	36,581 12 4	195,047 3 11	11,113 9 7	11,339 5 5	149,338 19 0	40,000 0 0	6,482 9 1	204,431 15 4
1892	463,741 5 4	236,252 0 5	227,489 4 11	40,239 5 8	187,249 19 3	5,482 9 1	25,915 5 2	152,333 16 6	10,000 0 0	4,483 6 8	234,370 11 2
1893	583,590 2 11	311,644 10 2	271,945 12 9	54,220 9 10	217,725 2 11	4,483 6 8	40,616 2 6	149,367 12 10	30,000 0 0	2,194 14 3	285,020 7 8
1894											
Twelve months to April 30th ...	682,950 14 1	344,168 19 7	338,781 14 6	63,254 17 2	275,526 17 4	2,194 14 3	48,266 18 5	168,957 15 0	...	60,496 18 2	334,985 13 4
Two months to June 30th	117,594 1 7	65,946 4 3	51,647 17 4	10,690 13 1	40,956 19 3	...	8,100 0 0	28,159 12 6	...	4,697 6 9	345,358 18 5
Fourteen months to June 30th ...	800,544 15 8	410,115 3 10	390,429 11 10	73,945 15 3	316,483 16 7	2,194 14 3	56,366 18 5	197,117 7 6	63,429 1 0	1,765 3 11	345,358 18 5

The Direct United States Cable Company, Limited.

THE report of the directors for the six months ended June 30th, 1894, states that the half-year's revenue, after deducting out payments, amounted to £34,843 9s. 4d., as compared with £40,836 17s. 4d. for the corresponding period of 1893, being a difference of £5,993 8s. against the half-year under review, which is attributable to the prolonged commercial depression. The working and other expenses for the same period, including income tax, amounted to £18,750 3s., leaving a balance of £16,093 6s. 4d. as the net profit of the half-year, making, with £3,080 10s. 10d. brought forward from the previous half-year, a total of £19,173 17s. 2d. For the corresponding period of 1893 the working expenses and other payments amounted to £18,898 5s. 7d. Three quarterly interim dividends, amounting to £25,801 15s., have been declared and paid during the financial year, and a final payment of 2s. per share is now proposed, making, with the three interim dividends, 2⅝ths per cent. for the year, being a total distribution of £31,872 15s. After transferring £6,000 to the reserve fund account, which now stands at £281,551 3s. 7d., the balance of £1,031 17s. 2d. on the revenue account is proposed to be carried forward. Pursuant to the provisions of the articles of association, two of the directors, viz.: Sir John Pender, G.C.M.G., M.P., and James Pender, Esq., J.P., retire by rotation, and being eligible, offer themselves for re-election. Mr. John G. Griffiths, F.C.A., and Mr. John Sawyer, F.C.A., the auditors, retire pursuant to the articles of association, and desire to offer their respective firms for election, viz.: Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. J. & J. Sawyer & Co.

West African Telegraph Company, Limited.

A MEETING of this company was held at Winchester House on Thursday last week, Sir John Pender presiding.

In moving the adoption of the report, the CHAIRMAN went into the figures in the balance-sheet, and said he sympathised with the shareholders in having again to go without a dividend, but they might rest assured that everything possible would be done to remedy this state of things. The fact was that this company had, so far, disappointed them. Unfortunately, their cable in the first instance had not been laid in proper water. They had now carried that portion of it in the Congo river district further out to sea. His own impression was that if they were fortunate, and their cable remained free from breakages, they would soon be in a better position.

Sir HENRY MANCE seconded the adoption of the report, which was carried.

The Metropolitan Electric Supply.—This company announces an issue of £150,000 4½ per cent. first mortgage debentures at 105 per £100 stock. This stock is redeemable at the company's option, on six months' notice on and after January 1st, 1916, at £110 for every £100 stock. The holders of the existing £100,000 5 per cent. registered debentures may exchange their debentures at par for debenture stock of this issue, receiving payment of interest at 5 per cent., accruing from June 1st to the 19th inst. All debentures not presented for conversion will be repaid on, and cease to bear interest at, the expiration of six calendar months.

City and South London Railway Company.—The accounts show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1 per cent. per annum. A balance of £1,335 is carried forward. The dividend for the corresponding period last year was at the rate of ¾ per cent. per annum, and the balance carried forward £898.

Anglo-American Telegraph Company, Limited.—The board have decided, after placing the sum of £12,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending June 30th, 1894, of 10s. per cent. on the ordinary stock and £1 per cent. on the preferred stock, less income tax, payable on August 1st to the stockholders registered on the books of the company on July 10th, 1894.

Venezuela Telephone and Electrical Appliances Company.—Coupon No. 8 of the 5 per cent. first mortgage debentures, due July 31st, will be paid from that date at the Consolidated Bank, Limited, Threadneedle Street, London, or at the banking house of Messrs. Westendorp & Co., Amsterdam.

The City of London Electric Lighting Company, Limited.—Warrants for the interim dividend due on this company's preference shares at the rate of 6 per cent. per annum for the six months ended June 30th last, have been posted.

National Telephone Company, Limited.—Letters of allotment in respect of the issue of £1,100,000 3½ per cent. debenture stock have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 15th, 1894, amounted to £882; week ending July 16th, 1893, £776; increase, £106: total receipts for half-year, 1894, £1,761; corresponding period, 1893, £1,845; decrease, £84.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 13th, after deducting 17 per cent. of the gross receipts payable to the London Platino-brazilian Telegraph Company, Limited, were £2,295.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, July 11th.	Closing Quotation, July 18th.	Business done during week ended July 18th, 1894. Highest.	Lowest.
184,500*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	100 —103	101 —104	102¾	...
1,134,640*l*	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	37 — 40	37 — 40	...	...
2,932,680*l*	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	71 — 73	71 — 73	73	71
2,932,680*l*	Do. do. Defd.	Stock	...	...	...	6½— 7	6½— 7	6¾	6⅝
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6¼% §	12 — 12½	12 — 12½	12¼	...
18,700*l*	Do. do. 5 % Bonds	100	...	...	...	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 %, repayable June 1906	100	...	...	...	107 -111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10% ‖ §	... §	1 — 2	1 — 2	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	139 —143	139 —143	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	2 % §	1/16 — 3/16	⅛ — ¼	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9 — 9½	9¼ — 9¾	9	...
30,000*l*	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	... ...	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	8½— 9½	8½— 9⅛	8 1/16	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	15¼— 15½	15⅜— 15⅝	15⅝	15⅜
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16 — 16½	16¼— 16⅞	16⅝	16
105,900*l*	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	...	...
1,294,100*l*	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	115 —118	116½	115½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15½— 15¾	15⅝— 15⅝xd	15⅝	15⅜
62,700*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	103½	...
222,800*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	114 —118	115 —119	118	...
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100*l*	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	105 —108	105 —108	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	10 3/16	108
180,227	Globe Telegraph and Trust, Ltd.	10	5⅛% §	4⅞% §	4⅝% §	8¼— 8½	8⅜— 8⅝	8½	8⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15¼— 15½	15⅜— 15⅝	15½	15¼
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	20½— 21	20½— 21	...	...
200,000*l*	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	44 — 46	44 — 46	45¼	44⅝
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	...	...	...	107 —110	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞— 5⅛	4¾— 5	5	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14½— 15½	14⅝	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅝— 5⅞	5½— 5¾	5¾	5 9/16
925,017*l*	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	109 —112	109 —112	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	½— ⅝	½— ⅝	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	101 —104	101 —104	101½	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5 — 6	5 — 6	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	110 —115	108 —113	110½	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900*l*	Do. do. do. 5 % Debs.	100	...	...	...	102 —105	102 —105	103	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½— 3	2½— 3	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	96 —101	96 —101	99	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	5 %	6½— 7	6¾— 7⅛	7⅛	6⅞
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5⅞— 6¼	5⅞— 6¼	5 13/16	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	1⅞— 2¼	1⅞— 2¼	...	...
178,200*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	107 —110	107 —110	...	...
222,700*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	107 —110	107 —110	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1¼	1 — 1¼	1	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10 — 10½	10 — 10⅛	10¼	...
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	107 —110 xd	107 —110	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
169,000*l*	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½— 5½	4½— 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12½— 13	12½— 13	12⅞	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14 — 14½	14 — 14½xd	14½	13⅞
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	127 —130	128 —130	129¾	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½%	5 %	5 %	6⅝— 6½	6½— 6⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	8½— 9	8¼— 8¾	8¾	8½
100,000*l*	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	109 — 112	106 —109	108	106½
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5½	4½— 5½	5	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	7 — 7½	7 — 7½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9	8½— 9	8⅝	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6¼— 6¾	6¼— 6¾	6 7/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share, ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, July 11th.	Closing Quotation, July 18th.	Business done during week ended July 18th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	...	6 % §	6 % §	2⅞— 3	2⅞— 3	2⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛— 2⅜	2⅛— 2⅛	2 7/16	2⅛
125,000*l*	Do. do. 4½ % Deb.	Stock	...	...	...	109 —112	110 —113	...	...
630,000*l*	City and South London Railway	Stock	...	£9%	£9%	36 — 38	36 — 38	37½	37
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	2½— 3	2½— 3	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¾— ⅞	¾— ⅞	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½— 1⅝	1½— 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd , 1 to 66,750 ...	2	*nil*	*nil*	*nil*	⅛— ¼	⅛— ¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1 — 1⅛	1⅛— 1⅛	1⅛	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	⅞— 1⅛	⅞— 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1⅛	½— 1⅛	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd , Ord.	10	5 %	5 %	5 %	6½— 7½	6½— 7½	7½	7
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23½— 24½	23 — 24 xd	23½	23⅜
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8 3/16— 8 5/16	8¼— 8¼	8¼	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12⅝— 13½	12⅞— 13½	13	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½%§	2 — 2⅛	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	40 — 42	40 — 42	41¼	40½
150,000*l*	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	104—107	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	... ...	2 — 2¼	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1⅜—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5¼—5½.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅞.

Liverpool Electric Supply, £5 (fully paid), 6¼—6⅜.

Do. do. £3 10s. paid, 4¼—4⅜.

London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Continued from page* 749.)

The Flashing of the Filament.

This process was not employed at the commencement of the incandescence lamp industry. It was invented by Maxim, and was first applied in the manufacture of the lamp bearing his name. It was afterwards adopted by all the lamp makers, one after another.

The object of the process is to form over the whole length of the filament a deposit of carbon similar to that made at two particular points in the jointing operation. (See "Jointing of the filament to its support.")

At first the motive for this deposit was somewhat different; Maxim's object was to regulate the section of the filament, and to give it more uniform conductivity. It must be observed that at that time the manufacture of the filament was in a very rough stage; the section obtained was not regular, and when the lamp was in use these differences of section, together with the want of homogeneousness, caused quite a different brilliancy at certain points or even certain portions of the filament. The filament was in fact a conductor, the section and specific conductivity of which varied from one place to another. It was soon found that these differences in the temperature of the various portions of the filament, besides being very disagreeable to the eye, were an obstacle to the good working of the lamps.

The flashing seemed to remedy these defects. It imparts to the most irregular filament a uniform aspect at least under the conditions under which the operation is effected. The mechanism on which it is based, moreover, when we examine it, seems calculated to give thoroughly satisfactory results.

If we place a filament of irregular section in a liquid or gaseous hydro-carbon, what happens? When we send the current into the filament, the points at which the section is smallest will become brighter, since their resistance per unit of length is greater. (We do not here take into account the specific resistance which we assume to be uniform throughout the mass of the filament.) The decomposition of the hydro-carbon produced by the high temperature, which is maintained in the filament by means of the electric current, will be more active in the immediate neighbourhood of these points, and consequently the deposit will be formed more rapidly. But as in proportion as the deposit is formed the resistance diminishes, the temperature keeps falling, and tends to become equal at all points. This result is of course obtained after a shorter or longer interval of time, according to the magnitude of the irregularities of the filament treated.

As can be seen by proceeding in this manner, the weak points are strengthened, and the hollows and pores of the filament are filled with this special carbon which the decomposition of the hydro-carbon produces.

If the flashing were perfect, *i.e.*, if it produced a filament of uniform section and conductivity at all points for all temperatures, it would be superfluous to look for a better process. Unfortunately, this is not the case; a filament originally irregular and brought by flashing to have the same brilliancy throughout its length has by no means a uniform section; as to its conductivity, it is only constant under certain well defined conditions.

What does this mean? Simply that the carbon deposited by flashing is different to that which constitutes the filament.

A flashed filament is, therefore, really a conductor formed of two parts possessing very different physical properties. In order that it may possess the properties of a homogeneous conductor, the sections of the two portions composing it must be uniform, *i.e.*, always in the same ratio at all points.

We shall, therefore, only obtain good results by starting

* *L'Electricien.*

with filaments that are absolutely regular, so that the operation of flashing seems superfluous. In fact, now that we have succeeded in obtaining directly filaments of perfect regularity, both as regards diameter and specific resistance, the flashing has lost its importance; it is, however, still generally used in virtue of the special qualities of the carbon deposited.

The carbon resulting from the decomposition, under certain fixed conditions, of hydro-carbons possesses remarkable properties.

The most important of these properties as regards the lamp, and that which leads us to have recourse to flashing even with perfectly regular filaments, notwithstanding the expense entailed by this operation, is the great density attained.

Flashing, then, really means covering the filament with a sheath of carbon of much greater density than the original carbon. It is, in fact, a protecting case, enabling the lamp to resist the disintegrating action of the current for a longer period. This is a fact proved by experiment, and must be due to the peculiar molecular structure of this carbon. It seems that it offers a greater resistance to the wrenching caused by the current, and, perhaps, it is not so readily oxidised. This sheath also increases the mechanical resistance of the filament. To the great density of the carbon deposited may be added a remarkable specific conductivity about ten times as great as that of the carbon of which a good filament is composed.

Unfortunately, the special qualities of the carbon deposited are essentially variable; in other words, they depend greatly on the conditions under which the deposit was produced.

The nature of the liquid or gas employed, its density, its pressure, if we are considering a gas, the temperature at which the decomposition is effected, are all causes which combine to produce deposits of carbon possessing absolutely different physical properties.

We can understand that, practically, it is rather difficult to reproduce exactly so many conditions; but, nevertheless, lamp makers succeed in doing so without much trouble. Their experience enables them to decide quickly what are the best possible conditions for a certain make of lamps, and if sufficient precautions are taken, these conditions can be reproduced with sufficient exactness for the result to be to all intents the same.

We will not here go into these conditions, as they vary according to the filament employed, the nature of the material used for flashing, the apparatus used for this operation, the kind of lamps required, and even, within certain limits, according to the practical working of the installation. If the flashing, when properly performed, imparts new qualities to the filament of the incandescence lamp, the operation may, if conducted without due attention to all the points already mentioned, prove disastrous and destroy all uniformity of manufacture.

On account of its great conductivity, the deposit of carbon obtained by flashing must be strictly equal for the same original diameter of filaments intended for lamps of the same type, or the filaments that were alike before the operation would be different afterwards.

As we have already seen, the nature of this deposit varies with the conditions of its production; at a lamp factory, therefore, a settled mode of procedure must be adopted and never departed from. This is essential, for the nature and all the physical properties of this special carbon must be well known before any kind of lamp can be calculated beforehand. The study of this deposit must be brought to bear upon all those properties that affect the lamp: specific resistance, variations of this resistance with the temperature, emissive power, &c.

When these different constants have been determined, both for the carbon forming the deposit and for that actually constituting the filament, the formulæ given in the first article on this subject can be applied.

It should be well understood that we must maintain, as strictly as possible, the conditions under which the constants were established, if we wish to ensure a successful result. It is certainly possible to construct lamps of a fixed type as regards luminous power and consumption starting from absolutely different original data, and this can easily be understood, since we can vary at once both the nature of the filament and that of the deposit; but such a mode of procedure would considerably complicate work which is already quite delicate enough under the simplest conditions; but there is another objection of considerable force, and that is the bad effect produced by lamps of the same luminous power placed side by side, and having filaments of very different dimensions.

In short, we repeat that flashing, instead of being at the present day an advantage and a means of regulating the filament, may become a source of disturbances in cases where the manufacture is not very carefully carried out; and this accounts for the fact that various makers have considered that it would be better to abandon a process that is seemingly advantageous, but requires great delicacy of manipulation.

If the lamps are to be made with filaments that are not flashed, the formulæ that we have given enable us to calculate the length and diameter suitable for a given type, that is, if we know the properties of the carbon constituting the filament, and if the manufacture is carried out so as to obtain similar results always, which is not a very difficult matter. If, on the contrary, the filaments are to be flashed, which is more often the case, it is not quite such a simple matter. The value of the constants figuring in these formulæ will depend both on the carbon constituting the filament and on that deposited on its surface; the resistance that enters into the calculation will be the resistance, when hot, of a conductor formed of two parts which act differently, *i.e.*, the variations of which with the temperature do not follow the same law; the section of the flashed filament, and consequently its surface, will no longer be that of the original filament; lastly, the length will have to be modified, since the surface has become greater, and the emissive power of this surface has been modified, and is now that of the carbon deposited.

Although the operation of flashing is delicate and complicated, and the causes of error seem very numerous and difficult to avoid, nevertheless, where the manufacture is well conducted, all these difficulties are overcome, and lamps are obtained which are so nearly identical, that the slight differences between them would escape even an expert; a result that every lamp manufacturer should endeavour to attain.

To do so we should try above all things to give a uniform brilliancy to all lamps of the same type as regards consumption; it is, in fact, the brilliancy, and not the total luminous power, that impresses the eye; and this is so true, that lamps of very different luminous power, placed side by side, and having the same brilliancy, seem to the eye more similar than those in which the luminous power is photometrically equal, but the consumption is not exactly the same.

The apparatus used for flashing are very varied. We have said that hydro-carburetted liquids or gases can be used. If we use liquids, the apparatus may be extremely simple. The filament is held by the two extremities of its support in two spring contacts, insulated from one another (this is the clutch, of which we spoke when describing the jointing, without the transverse bar), and the whole is immersed in the liquid. It is evident that the difference of potential to be established at the extremities of the filament will be much higher than that which is necessary to render the finished lamp incandescent; the intensity will consequently also be much greater; the proportion is about 1 to 5. This quantity of energy is absorbed through the conductivity of the liquid, or rather of the gaseous sheath which envelops the incandescent filament in the liquid; it follows therefore that it is proportional, other things being equal, to the pressure of the gas in which the operation is being effected, and that it will be less if the gas is used for the flashing than if a liquid is used.

If we use hydro-carburetted gases, the apparatus is much more complicated. It is necessary in this case to be able to regulate the pressure of the gas and measure it; we should then obtain an air-tight enclosure, so that when once this pressure is established and measured, we can assume, without making any great error, that it remains constant. For this purpose we use vessels closed by the clutch that should hold the filament. These apparatus are provided with manometers, indicating the variations of the internal pressure to be followed. The clutches holding the filaments are similar to those employed in the previous method. The form of these apparatus may be infinitely varied; but the main point is that their manipulation should be easy, sure and

quick. There are certain indispensable precautions to be taken with regard to flashing by means of hydro-carburetted gases. These gases are all inflammable when exposed to the air, and even combine with it to form explosive mixtures. Care must be taken, therefore, before sending the current into the filament, to drive the air out of the apparatus as completely as possible. We have not only to provide against an explosion which would damage the apparatus, but also the risk of damaging the filaments through the presence of ever so small a quantity of air. Keys moved automatically may be used to provide against these accidents; but it is preferable to entrust these precautions to a skilled and trustworthy staff of employés. Commutators placed within reach of the operator, a regulating rheostat, apparatus for measuring resistances, difference of potential and intensity, complete the installation required for the flashing.

The operation of flashing may be effected in different ways. We will briefly describe one method.

The filament, when fastened to its support and ready for the flashing, has a diameter and a length determined by calculation. We must also calculate the resistance when cold that should be offered by the filament of a lamp of a certain type under the conditions in which the flashing is performed at the works. The operator then takes this filament, places it in its clutch, introduces it into the flashing apparatus, and maintains in this apparatus the required pressure. He then sends into it the current, increasing it by manipulating the variable resistance at his disposal until he obtains the intensity suited to the type of filament under treatment. The filament becomes covered with the carbon deposited, and at the end of a shorter or longer period, according to the mode of procedure adopted, he ascertains whether the resistance, when cold, of the filament really is that assigned to it by calculation. The operation is then finished, and the filament is taken out of the apparatus.

(*To be continued.*)

PROCEEDINGS OF SOCIETIES.

Royal Society.

"On the Electrification of Air,"* by Lord Kelvin, P.R.S., and Magnus Maclean, M.A., F.R.S.E. Received May 9th, 1894.

Section 1.—That air can be electrified either positively or negatively is obvious from the fact that an isolated spherule of pure water, electrified either positively or negatively, can be wholly evaporated in air.† Thirty-four years ago it was pointed out by one of us‡ as probable, that in ordinary natural atmospheric conditions, the air for some considerable height above the earth's surface is electrified,§ and that the incessant variations of electrostatic force which he had observed, minute after minute, during calms and light winds, and often under a cloudless sky, were due to motions of large quantities of positively or negatively electrified air in the immediate neighbourhood of the place of observation.

Section 2.—It was proved‖ by observations in the Old College of Glasgow University that the air was in general negatively electrified, not only indoors, within the old lecture¶ room of Natural Philosophy, but also in the out-of-doors space of the College Court, open to the sky though closed around with high buildings, and between it and the top of the College Tower. The Old College was in a somewhat low situation, surrounded by a densely crowded part of a great city. In the new University buildings, crowning a hill on the western boundary of Glasgow, similar phenomena, though with less general prevalence of negative electricity in the air, have been observed, both indoors, in the large Bute Hall, and in many other smaller rooms, and out-of-doors, in the court, which is somewhat similar to the courts of the Old College, but much larger. It is possible that the negative electricity found 30 years ago in the air of the Old College, may have been due to its situation, surrounded by houses with their fires, and smoking factory chimneys. In the New College much of the prevalence of negative electricity in air within doors has, however, been found to be due to electrification by the burning lamp** used with the quadrant electrometer; and more recent observations, with electrification by flame absolutely excluded, throw doubt on the old conclusion, that both in town and country negative electrification is the prevailing condition of natural atmospheric air in the lower regions of the atmosphere.

Section 3.—The electric ventilation found in the Old College, and described in section 299, of "Electrostatics and Magnetism," according to which air drawn through a chink, less than ½-inch wide, of a slightly open window or door, into a large room, showed the electrification which it had on the other side of the chink, whether that was the natural electrification of the open air, or positive or negative electrification produced by aid of a spirit lamp and electric machine in an adjoining room, has been tried again in the new college with quite corresponding results. It has also been extended to the drawing in of electrified air through a tube to the enclosure represented in fig. 1 of the present paper; with the result that the water-

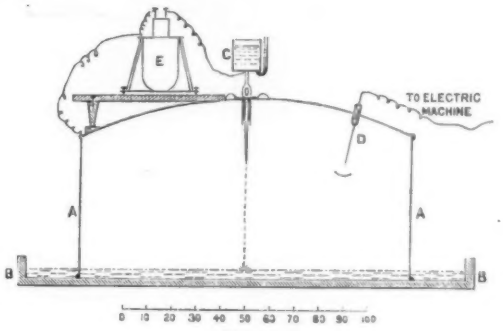


Fig. 1.

dropping test indicated in the sketch, amply sufficed to show the electrification, and verify that it was always the same as that of the air outside. When the tube was filled with loosely packed cotton wool the electrification of the entering air was so nearly annulled as to be insensible to the test.

Section 4.—The object proposed for the experiments described in the present communication was to find if a small unchanged portion of air could be electrified sufficiently to show its electrification by ordinary tests, and could keep its electrification for any considerable time; and to test whether or not dust in the air is essential to whatever of electrification might be observed in such circumstances, or is much concerned in it.

Section 5.—The arrangement for the experiments is shown in the diagram fig. 1. A, A is a large sheet-iron vat inverted on a large wooden tray, B, B, lined with lead. By filling the tray with water the air is confined in the vat. There are two holes in the top of the vat, one for the water dropper, C, and one for the charging wire, D. Both the water-dropper and the charging wire ending with a pin point as sharp as possible, are insulated by solid paraffin, which is

* Read before the Royal Society.

† This demonstrates an affirmative answer to the question, Can a molecule of a gas be charged with electricity? (J. J. Thomson, "Recent Researches in Electricity and Magnetism," section 36, p. 53), and shows that the experiments referred to as pointing to the opposite conclusion are to be explained otherwise.

Since this was written, we find, in the Electrical Review of May 18th, on page 571, in a lecture by Elihu Thomson, the following:—"It is known that as we leave the surface of the earth and rise in the air, there is an increase of positive potential with respect to the ground. . . . . It is not clearly proven that a pure gas, rarefied or not, can receive and convey a charge. If we imagine a charged drop of water suspended in air and evaporating, it follows that, unless the charge be carried off in the vapour, the potential of the drop would rise steadily as its surface diminished, and would become infinite as the drop disappeared, unless the charge were dissipated before the complete drying up of the drop by dispersion of the drop itself, or conveyance of electricity by its vapour. The charge would certainly require to pass somewhere, and might leave the air and vapour charged."

It is quite clear that "must" ought to be substituted for "might" in this last line. Thus the vagueness and doubts expressed in the first part of the quoted statement are annulled by the last three sentences of it.

‡ "Even in fair weather the intensity of the electric force in the air near the earth's surface is perpetually fluctuating. The speaker had often observed it, especially during calms or very light breezes from the east, varying from 40 Daniell's elements per foot to three or four times that amount during a few minutes, and returning again as rapidly to the lower amount. More frequently he had observed variations from about 30 to about 40, and back again, recurring in uncertain periods of perhaps about two minutes. These gradual variations cannot but be produced by electrified masses of air or cloud, floating by the locality of observation."—Lord Kelvin's "Electrostatics and Magnetism," art. xvi., section 282.

§ The out-of-doors air potential, as tested by a portable electrometer in an open place, or even by a water-dropping nozzle outside, two or three feet from the walls of the lecture room, was generally on these occasions positive, and the earth's surface itself therefore, of course, negative—the common fair weather condition—which I am forced to conclude is due to a paramount influence of positive electricity in higher regions of the air, notwithstanding the negative electricity of the air in the lower stratum near the earth's surface. On the two or three occasions when the indoor atmospheric electricity was found positive, and, therefore, the surface of the floor walls and ceiling negative, the potential outside was certainly positive, and the earth's surface out-of-doors negative, as usual in fine weather."—*Ibid.*, section 300.

‖ *Ibid.*, Q. 2, section 283.

¶ *Ibid.*, sections 296—300.

** "Electrification of Air by Combustion." Magnus Maclean, M.A., F.R.S.E., and Makita Goto, Philosophical Society of Glasgow, November 20th, 1889; "Electrification of Air by Water Jet," Magnus Maclean, M.A., F.R.S.E., and Makita Goto, *Philosophical Magazine*, August, 1890.

surrounded by a metal tube, as shown in half size in fig. 2. To start with they were supported by pieces of vulcanite embedded in paraffin. But it was found that after the lapse of some days (possibly on account of ozone generated by the incessant brush discharges), the insulation had utterly failed in both of them. The vulcanite pieces were then taken out, and solid paraffin, with the metal guard tube round it to screen it from electrically influencing the water-dropper, was substituted. This has proved quite satisfactory: the water-dropper, with the flow of water stopped, holds a positive or a negative charge for hours.

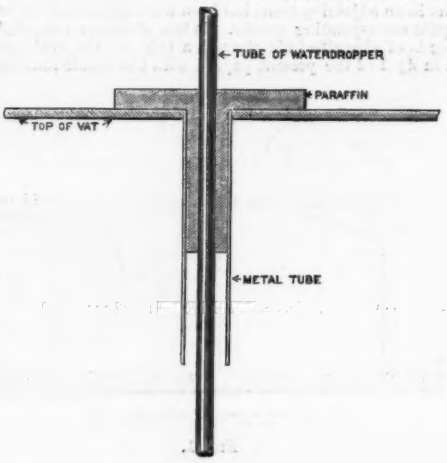


FIG. 2.

Section 6.—A quadrant electrometer, E (described in "Electrostatics and Magnetism" sections 346—353) was set up on the top of the vat near the water-dropper, as shown in fig. 1. It was used with lamp and semi-transparent scale to indicate the difference of potential between the water-dropper and the vat. The sensibility of the electrometer was 21 scale divisions (half-millimetres) per volt, and as the scale was 90 centimetres long, difference of potentials up to 43 volts positive or negative, could be read by adjusting the metallic zero to the middle of the scale. A frictional plate-electric machine was used, and by means of it, in connection with the pin-point, the air inside the vat could be electrified either positively or negatively.

Section 7.—The vat was fixed in position in the apparatus room of the natural philosophy department of the University of Glasgow on December 13th, 1893, and for more than three months the air inside was left undisturbed except by discharges from the pin-point through the electrifying wire, and by the spray from the water-dropper. Thus the air was becoming more and more freed of dust day by day. Yet at the end of the four months we found that the air was as easily electrified, either positively or negatively, as it was at the beginning; and that if we electrify it strongly by turning the machine for half-an-hour, it retains a considerable portion of this electrification for several hours.

Section 8.—Observations were taken almost daily since December 13th; but the following, taken on February 8th, March 12th, and April 23rd, will serve as specimens, the results being shown in each case by a curve. At all these dates the air must have been very free from dust. Both during the charging and during the observations the case of the electrometer and one pair of quadrants are kept metallically connected to the vat. During the charging the water-dropper and the other pair of quadrants were also kept in connection with the vat. Immediately after the charging was stopped the charging-wire was connected metallically to the outside of the vat, and left so with its sharp point unchanged in its position inside the vat during all the observations.

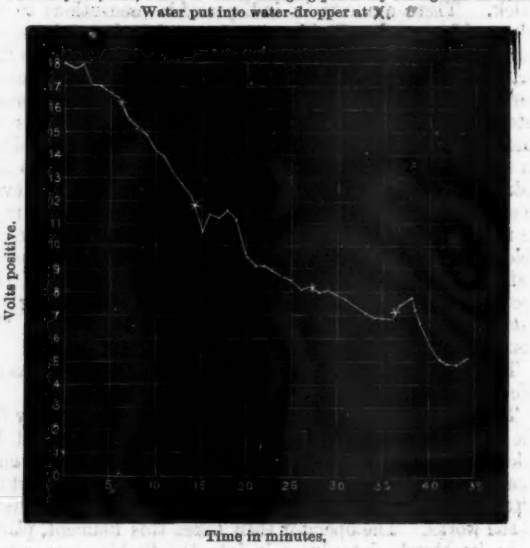
Section 9. *Curve* 1. *February 8th*, 1894.—The friction-plate machine was turned positive for half-an-hour. Ten minutes after the machine stopped the water-dropper was filled and joined to one pair of quadrants of the electrometer, while the other pair was joined to the case of the instrument. The first reading on the curve was taken four minutes afterwards, that is fourteen minutes after the machine stopped running (18 volts.)

Curve 2. *March 3rd*, 1894.—The friction-plate machine was turned positive for five minutes. The water-dropper was filled and joined to the electrometer immediately after the machine stopped turning. The spot was off the scale, and nine minutes elapsed before it appeared on the scale. The first reading on the curve was taken one minute afterwards, or ten minutes after the machine stopped turning (35·25 volts.)

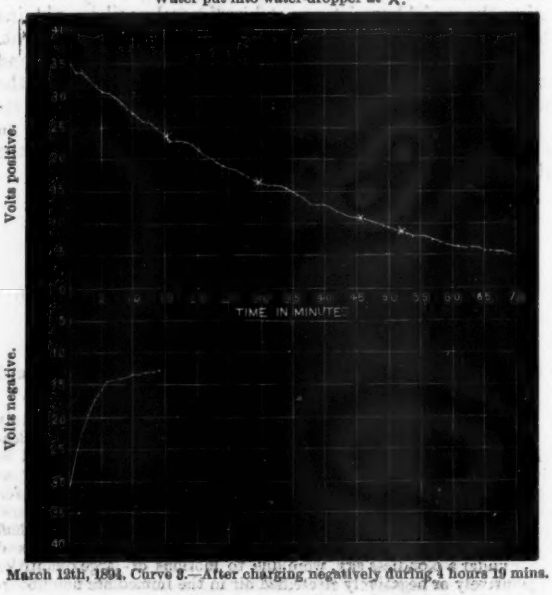
Curve 3. *March 12th*, 1894.—A Voss induction machine was joined to the charging wire, and run by an electric motor for four hours 19 minutes. A test was applied at the beginning of the run to make sure that it was charging negatively; and a similar test when it was disconnected from the charging wire in the vat showed it to be still charging negatively. The water-dropper was joined to the electrometer, and the spot appeared on the scale immediately. The first reading on the curve was taken half a minute after the machine was disconnected (30·65 volts).

Curve 4. *April 23rd*, 1894.—The friction-plate machine was turned positive for 30 seconds, with water-dropper running and joined to the electrometer. 20 seconds after the machine stopped the spot

February 8th, 1894, Curve 1.—After charging positively during half an hour. Water put into water-dropper at X.

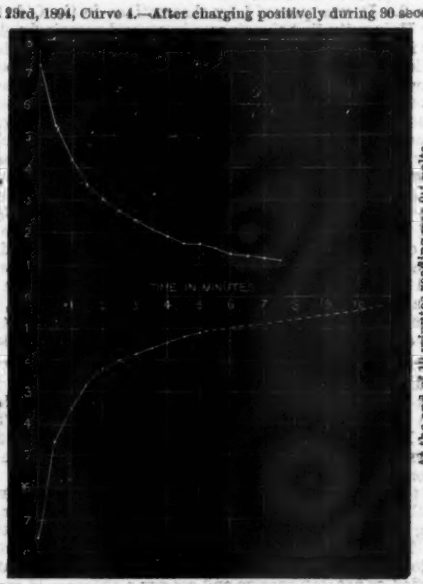


March 3rd, 1894, Curve 2.—After charging positively during five minutes. Water put into water-dropper at X.



March 12th, 1894, Curve 3.—After charging negatively during 4 hours 19 mins.

April 23rd, 1894, Curve 4.—After charging positively during 30 seconds.



April 23rd, 1894, Curve 5.—After charging negatively during 30 seconds.

appeared on the scale, and the reading 1½ minutes after the machine stopped turning is the first point on the curve (7·3 volts.)

Curve 5. *April* 23*rd*, 1894.—The friction-plate machine was turned negative for 30 seconds, with the water-dropper running and joined to the electrometer. 10 seconds afterwards the spot appeared on the scale, and the reading 70 seconds after the machine stopped turning is the first point on the curve (7·6 volts).

The curves show, what we always found, that the air does not retain a negative electrification so long as it retains a positive. We also found, by giving equal numbers of turns to the machine that the immediately resulting difference of potential between the water-dropper and the vat was greater for the negative than for the positive electrification; though the quantity received from the machine was probably less in the case of the negative electrification, because the negative conductor was less well insulated than the positive.

Section 10.—On March 21st two U-tubes were put in below the edge of the vat, one on either side, so that it might be possible to blow dusty, or smoky, or dustless air into the vat. To one tube was fitted a blow pipe bellows, and by placing it on the top of a box in which brown paper and rosin were burning, the vat was filled with smoky air. Again, several layers of cotton-wool were placed on the mouth of the bellows, so as to get dustless air into the vat. The bellows were worked for several hours on four successive days, and we found no appreciable difference (1) in the ease with which the air could be electrified by discharges from the wire connected to the electric machine, and (2) in the length of time the air retains its electrification.

But it was found that, as had been observed four years ago with the same apparatus,* with the water-dropper insulated and connected to the electrometer, and no electrification of any kind to begin with, a negative electrification amounting to four, five, or six volts gradually supervened if the water-dropper was kept running for 60 or 70 minutes, through air which was dusty, or natural, to begin with. It was also found, as in the observations of four years ago, that no electrification of this kind was produced by the dropping of the water through air purified from dust.

The circular bend of the tube of the water-dropper shown in the drawing was made for the purpose of acting as a trap to prevent the natural dusty air of the locality from entering the vat when the water-dropper ran empty.

Section 11.—The equilibrium of electrified air within a space enclosed by a fixed bounding surface of conducting material presents an interesting illustration of elementary hydrostatic principles. The condition to be fulfilled is simply that the surfaces of equal electric "volume-density" are surfaces of equal potential, if we assume that the material density of the air at given temperature and pressure is not altered by electrification. This assumption we temporarily make from want of knowledge; but it is quite possible that experiment may prove that it is not accurately true; and it is to be hoped that experimental investigation will be made for answering this very interesting question.

Section 12.—For stable equilibrium it is further necessary that the electric density, if not uniform throughout, diminishes from the bounding surface inwards. Hence, if there is a portion of non-electrified air in the enclosure it must be wholly surrounded by electrified air.

Section 13.—We may form some idea of the absolute value of the electric density, and of the electrostatic force in different parts of the enclosure, in the electrifications found in our experiments, by considering instead of our vat a spherical enclosure of diameter intermediate between the diameter and depth of the vat which we used. Consider, for example, a spherical space enclosed in metal of 100 cm. diameter, and let the nozzle of the water-dropper be so placed that the stream breaks into drops at the centre of the space. The potential shown by the electrometer connected with it, being the difference between the potentials of the air at the boundary and at the centre, will be the difference of the potentials at the centre due respectively to the total quantity of electricity distributed through the air and the equal and opposite quantity on the inner boundary of the enclosing metal; and we therefore have the formula:—

$$v = 4\pi \int_0^a \rho \left(\frac{r^2}{r} - \frac{r^2}{a} \right) dr,$$

where v denotes the potential indicated by the water-dropper, a the radius of the spherical hollow, and ρ the electric density of the air at distance r from the centre. Supposing now, for example, ρ to be constant from the surface to the centre (which may be nearly the case after long electrification as performed in our experiments), we find $v = \frac{2}{3}\pi\rho a^2$; whence $\rho = 3v/2\pi a^2$.

To particularise further, suppose the potential to have been 38 volts or 0·127 electrostatic C.G.S. (which is less than the greatest found in our experiments), and take $a = 50$ cm.: we find $\rho = 2{\cdot}4.10^{-5}$. The electrostatic force at distance r from the centre, being $\frac{4}{3}\pi\rho r$, is therefore equal to $10^{-4}\,r$. Hence a small body electrified with a quantity of electricity equal to that possessed by a cubic centimetre of the air, and placed midway ($r = 25$) between the surface and centre of the enclosure experiences a force equal to $2{\cdot}4.10^{-3}.25$, or $6{\cdot}10^{-3}$, or approximately $6{\cdot}10^{-5}$ gramme weight. This is 4·8 per cent. of the force of gravity on a cubic centimetre of air of density 1/800.

Section 14.—Hence we see that, on the supposition of electric density uniform throughout the spherical enclosure, each cubic centimetre of air experiences an electrostatic force towards the boundary in simple proportion to distance from the centre, and amounting at the boundary to nearly 10 per cent. of the force of gravity upon it; and electric forces of not very dissimilar magnitudes must have acted on the air electrified as it actually was in the non-spherical enclosure used in our experiments. If natural air or cloud, close to the ground and in the lower regions of the earth's atmosphere, is ever, as in all probability it often is, electrified to as great a degree of electric density as we have found it within our experimental vat, the natural electrostatic force in the atmosphere, due as it is, no doubt, to positive electricity in very high regions, must exercise an important pondero-motive force quite comparable in magnitude with that due to difference of temperatures in different positions.

It is interesting to remark that negatively electrified air over negatively electrified ground, and with non-electrified air above it, in an absolute calm, would be in unstable equilibrium; and the negatively electrified air would therefore rise, probably in large masses, through the non-electrified air up to the higher regions, where the positive electrification is supposed to reside. Even with no stronger electrification than that which we have had within our experimental vat, the moving forces would be sufficient to produce instability comparable with that of air warmed by the ground and rising through colder air above.

Section 15.—During a thunderstorm the electrification of air, or of air and the watery spherules constituting cloud, need not be enormously stronger than that found in our experiments. This we see by considering that if a uniformly electrified globe of a metre diameter produces a difference of potential of 38 volts between its surface and centre, a globe of a kilometre diameter, electrified to the same electric density, reckoned according to the total electricity in any small volume (electricity of air and of spherules of water, if there are any in it), would produce a difference of potential of 38 million volts between its surface and centre. In a thunderstorm, flashes of lightning show us differences of potentials of millions of volts, but not perhaps of many times 38 million volts, between places of the atmosphere distant from one another by half a kilometre.

* Maclean and Goto, *Philosophical Magazine*, August, 1890.

NEW PATENTS—1894.

12,767. "Improvements relating to electric incandescent lamps." W. H. WILLATT. Dated July 2nd.

12,816. "Improvements in or relating to marine engine telegraphs and similar devices." B. G. HJARNE. Dated July 2nd.

12,817. "Improvements in electric incandescent lamps." A. ZOBEL and F. BUCHMULLER. Dated July 2nd.

12,861. "New or improved electrical fishing apparatus." E. POPPOWITSCH and H. WUSTENFELD. Dated July 3rd. (*Complete.*)

12,870. "Improvements in electric switches." C. HAMILTON. Dated July 3rd.

12,875. "Improved alternating current meter and method of measuring alternating currents." J. F. KELLY and W. STANLEY. Dated July 3rd. (*Complete.*)

12,877. "Improvements relating to the operation and control of steam machinery or other mechanism by means of electricity, and in apparatus therefor." H. H. LAKE. (Communicated by J. D. Williamson, Jun., United States.) Dated July 3rd. (*Complete.*)

12,928. "Improvements in or in connection with the commutator brushes of dynamos." J. A. EDMONDSON. Dated July 4th.

12,946. "Improvements in arc electric lamps." S. SEALY-ALLIN and W. H. WOOD. Dated July 4th.

12,965. "An improved contrivance for automatically switching on and off electric currents suitable for many purposes." G. B. BLANCHARD and A. BALLANCE. Dated July 4th.

12,972. "Improvements in electric arc lamps and current regulators therefor." S. DOUBRAVA and J. DONAT. Dated July 4th. (*Complete.*)

12,973. "An improved device for casting electric accumulator plates." C. HAMPEL. Dated July 4th.

12,982. "Improvements in electric arc lamps." J. BROCKIE. Dated July 4th.

12,991. "An automatic cut-out for electrical heating and cooking appliances." J. A. MACMEIKAN. Dated July 4th.

12,993. "Improvements in the electrolytic separation of gold from ores." A. CRUICKSHANK. Dated July 4th.

13,018. "Improvements in electrical firing keys." H. V. KREESON. Dated July 5th.

13,042. "An improved contrivance for automatically switching on and off electric currents, also suitable for many purposes." G. B. BLANCHARD and A. BALLANCE. Dated July 5th.

13,063. "Indicating lamp failures in electric lighting circuits and apparatus therefor." G. J. T. J. PARFITT. Dated July 5th.

13,078. "An electric-resistance switch improvement for lowering incandescent lamps." E. R. CUMMINS. Dated July 6th.

13,082. "A method of and apparatus for fixing or erecting telephonic, telegraphic, or other wires." C. SHORE. Dated July 6th.

13,110. "Improvements in the manufacture, from carbonaceous matter, of plates, slabs, rings, crucibles, rollers, bars, rods, pipes, and other articles, for electrical, electrolytical, and other purposes." C. P. SHREWSBURY, F. L. MARSHALL, J. COOPER, and J. L. DOBELL. Dated July 6th.

13,115. "Improvements in telephonic transmitters." G. A. NUSSBAUM. Dated July 6th.

13,136. "Improvements in or appertaining to submarine telegraph and like cables." H. A. TAYLOR and J. A. L. DEARLOVE. Dated July 6th.

13,148. "Improvements in electrical measuring and recording instruments." H. T. HARRISON. Dated July 6th.

13,157. "Improvements in means for insulating electric cables." G. E. Heyl. Dated July 6th.

13,158. "Improvements in electric fuses." G. E. Heyl. Dated July 6th.

13,160. "Improvements in the manufacture of electric cables." G. G. M. Hardingham. (Communicated by the Firm of Felten and Guilleaume, Germany.) Dated July 6th.

13,182. "Improvements in electric light ceiling roses." C. Richardson and E. Herbert. Dated July 7th.

13,208. "Improvements in field-magnets for continuous-current dynamos." W. H. Allen, R. W. Allen, and C. C. Hawkins. Dated July 7th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

19,194. "Improvements in telephones and in the application thereof to railway signalling." C. Langdon-Davies. Dated October 25th. Claims:—1. The combination, substantially as described, of block signal instruments and telephone instruments having coils of high resistance alloy on the same line wires. 2. Telephone transmitters, substantially as described, having the coils in the secondary circuit of high resistance alloy.

19,714. "Improvements in dynamo-electric machines." H. Chitty. Dated November 2nd. Claim:—A dynamo-electric machine having an armature with ventilation passages left at intervals between its conductors and between groups of the plates of which it is built up, and field magnets with corresponding ventilation passages through their pole-pieces, substantially as and for the purpose set forth.

21,480. "Improvements in the means or apparatus for measuring electricity." G. L. Anders and W. Kottgen. Dated November 25th. Consists mainly in the utilisation of the fluidity of a metal such as mercury, the meter being arranged in such a manner that the amount of mercury deposited on a plate such as platinum—or it may be on a mercurial surface—shall flow therefrom into an indicating tube or similar device, so that the amount may be seen at a glance, the general appearance of the meter being like an inverted mercurial thermometer. 4 claims.

23,023. "An improved system of telephonic news transmitter." T. Puskas. Dated December 14th. According to the improvements, the induction receiver coils are actuated by currents of a higher order, whereby it is rendered possible to use a single telephone transmitter for any number of receivers, or, in other words, to transmit the voice of the speaker to any desired number of places; and each receiver coil is arranged at the receiver's place or in its vicinity. 2 claims.

1893.

36. "Improvements in electrical station and stopping-place indicators for vehicles." F. Villiers-Stead. Dated January 2nd. Consists of a toothed ratchet carrying a disc, upon which the names of the various stations or streets are printed. The ratchet is worked by an armature influenced by electro-magnets; upon the armature, and upon the poles of the electro-magnets, are fixed blocks of soft iron, so fixed to interlock when circuit is closed, thus securing a larger and more powerful pull upon the armature. On this armature is a fixed or movable toe; on the closing of the circuit, this toe acting on a tooth of the ratchet, pushes forward the disc, thus showing the name of the next station or street on the indicator. The apparatus can be worked automatically by a make-and-break attachment fixed to the guard's van, which acts by being brought in contact by a hanging bar, with a projecting flange fixed alongside the rail, fixed just outside of the leaving part of the station. 4 claims.

2,922. "Improvements in electric clocks." H. Scott and H. K. Burnet. Dated February 9th. Has reference to those clocks in which the power to drive the train of wheels is obtained by a battery acting on a pendulum, or balance wheel, through an electro-magnet. 4 claims.

3,413. "Improvements in recording instruments for electric telegraphs." A. Muirhead and R. H. Edgar. Dated February 15th. Consists essentially of a narrow rectangular coil of insulated wire suspended between the poles of a magnet of horse-shoe or other convenient shape, and without the soft iron core which is fixed inside the coil of the instruments hitherto employed. The coil is suspended and held in position by a fibre or wire above and beneath it, and is connected to the aluminium frame which carries the glass syphon by means of two fibres of silk or other suitable material. These two fibres, together with the torsional elasticity of the stretched wire by means of which the syphon is suspended, give the requisite directive force to the coil. A small electro-magnet is fixed at one end of the bridge-piece carrying the syphon suspension, and beneath the iron core of this electro-magnet is a small armature of iron attached to the stretched wire on which the syphon rides. A vibratory current is passed through the coil of this electro-magnet from a make-and-break apparatus of similar construction to that of an electric trembling-bell. 4 claims.

3,690. "A combined ammeter and voltmeter." W. R. Morris. Dated February 20th. The inventor constructs a case of metal or other suitable material, and fits therein two solenoids or any other arrangement for producing the same result, viz., moving two hands or pointers; one solenoid is used for indicating the electromotive force in volts, and this solenoid moves the hand which has the word volts marked on it; the other solenoid is used for indicating the current in ampères, and this hand has the word amps. marked on it. The solenoids are connected to terminals on the case.

11,749. "Improvements in heating liquids by electricity." A. B. Woakes. Dated June 14th. Relates, first, to improvements in the heating of water and other liquids by electricity, by the method described in Specification dated January 6th, 1892, No. 259, wherein the liquid itself is made the resisting medium to the passage of the current for the purpose of utilising the electrical energy for heating the liquid. It also relates to improvements in the heating of liquids by the passage of a current through an insulated conductor embedded in the tube or immersed in the liquid, and not through the liquid itself. 4 claims.

12,139. "Improvements in electric machines and transformers." M. Hutin and M. Leblanc. Dated June 20th. The inventors employ a number of armature coils or sections which is a multiple of 4, and provide a commutator with an equal number of segments insulated from each other. They connect in series all the even sections of the armature, and connect them to the even segments of the commutator; and in like manner they connect the old sections and segments, so that practically two distinct armatures are thus constituted, which may be termed the one even, the other odd. They provide two brushes placed opposite to each other, but each of such width that it cannot touch more than two segments at a time. When the brushes touch only even or odd segments, the even or odd armature alone is acting, when each brush touches at the same time an even and an odd segment, the two armatures are connected in parallel, and act together. 3 claims.

21,430. "Improvements relating to incandescent electric lamps." C. J. P. Robertson. Dated November 10th. Consists in affixing metallic hooks or supports for holding the filaments in position to the bulbs when the latter are evacuated, or free of any oxidising agent, so that cheap or oxidisable metals or alloys can be used for such hooks or supports.

21,734. "Improvements in dynamo-electric machines." D. H. Wilson. Dated November 14th. Has for its object to provide a simple, cheap, convenient and highly efficient machine; also, to provide means for controlling the machine; also to provide means for the convenient use of double poles and armatures in one and the same mechanism, and in various improvements as set out, and to provide a machine with a field having an exceedingly short magnetic circuit. 6 claims.

22,131. "Improvements in switches for controlling electric current circuits in parallel supply systems." W. Lowrie. Dated November 18th. Relates to improvements in switches for controlling electric current circuits, whereby when certain conditions are produced—either automatically or by hand—electrical contacts are made or broken automatically. 4 claims.

22,594. "Improvements in arc electric lamps." W. J. Davy. Dated November 25th. By means of the improvements the inventor produces an arc lamp having little weight and of a compact and simple form. 7 claims.

23,017. "An improved arc lamp." H. R. Low and F. R. Brown. Dated November 30th. Relates to the construction of an electric arc lamp, and its object is to simplify the mechanism by which the carbons are made to approach each other. 1 claim.

23,697. "Improvements relating to electric signalling or the transmission of information and energy by electricity, and to apparatus therefor." C. J. Reed. Dated December 12th. Is directed particularly to a novel method of, and apparatus for, transmitting intelligible signals electrically between two or more distant points through the agency of induced currents of electricity, and also to a novel arrangement of inductive circuits. 21 claims.

23,913. "Improved process and apparatus for dissociating soluble salts by electricity." R. Haddan. (A communication from abroad by H. S. Blackmore, of America.) Dated December 12th. Is based on the discovery that the dissociation of soluble salts by electrolysis can be effected with great facility by providing a bath of the electrolyte and two independent bodies of liquid, establishing a dialytic communication between the bath and each of the independent bodies of liquid, maintaining the independent bodies of liquid at a higher level than the level of the bath, and passing a current of electricity through the independent bodies and through the bath. 6 claims.

24,608. "Improvements in the construction of and in the means for fixing fly-wheels to the pulleys of dynamo-electric motors and generators." E. A. Claremont. Dated December 21st. Claim:—In dynamo-electric motors and generators, the use of a steel or iron boiler plate fly-wheel fitted thereto, and constructed in the manner and for the purpose substantially as described.

24,865. "Improvements in insulators for electric wires." H. H. Lake. (Communicated from abroad by W. B. Rand, of America.) Dated December 27th. Relates more particularly to insulators for indoor construction, such as those which are employed for supporting and insulating wires which are carried through buildings and the like. 4 claims.

24,867. "Improvements in electric railways." J. C. Love and A. G. Wheeler. Dated December 27th. Relates to improvements in electric railways of that class wherein the electric conductor or conductors conveying the currents from the central generating plant to the motors on the cars are located within a slotted conduit beneath the surface of the roadway, and wherein travelling contact devices are attached to the car, and extend into the said conduit for conducting the current from the conductors therein to the car. 42 claims.